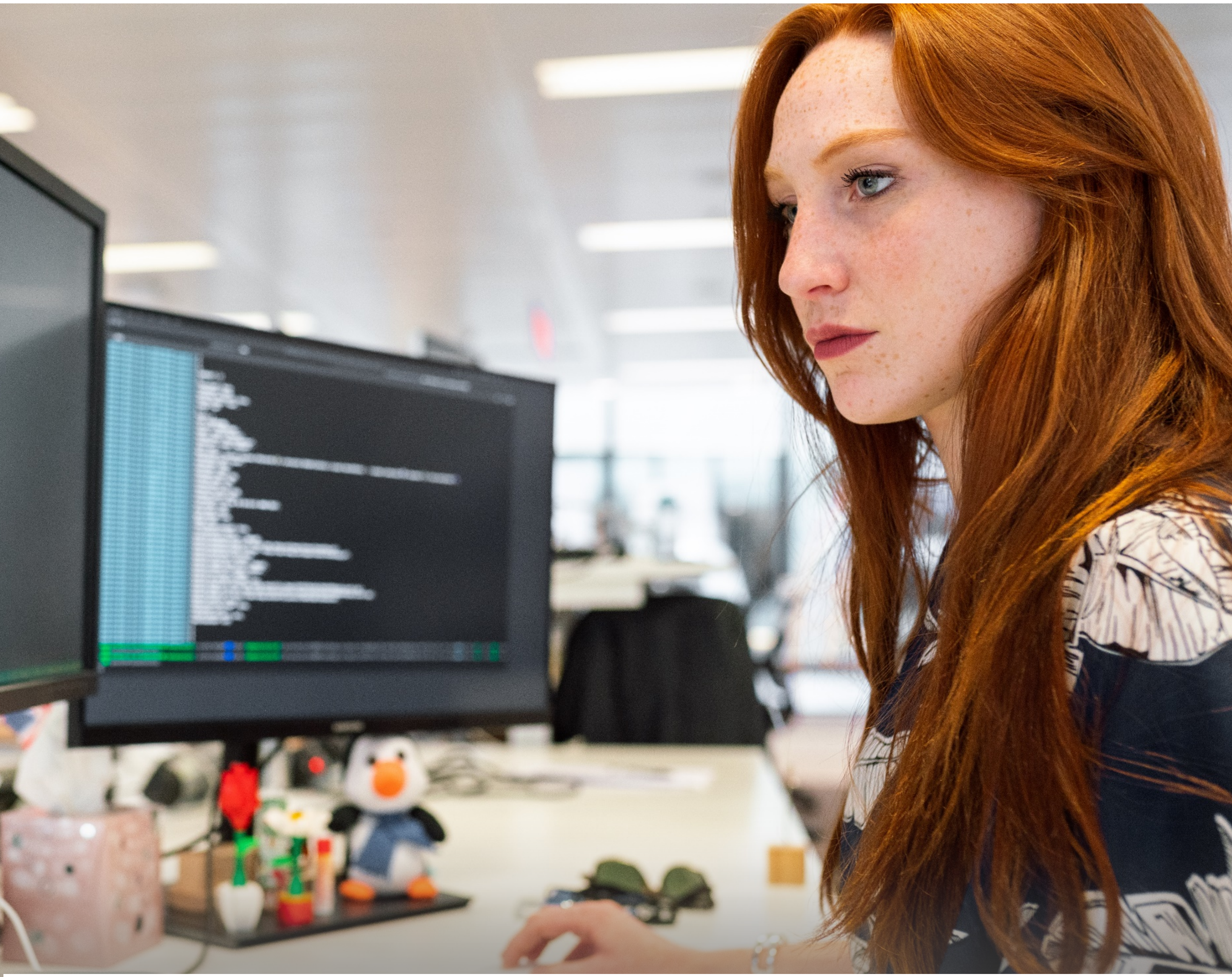

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Trust, Integrity, and Science Ethics

Government Science and Innovation in the New Normal
Discussion Paper

Dr. Ravtosh Bal I November 2022

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ABOUT GSINN – CANADA NEEDS A NEW RELATIONSHIP WITH SCIENCE THAT REFLECTS OUR TIME

In December 2020, the Institute on Governance launched *Government Science and Innovation in the New Normal (GSINN),* a multi-year, collaborative research initiative designed to explore the impact of the pandemic on federally-performed science and innovation, to support medium-term planning for federal science and innovation departments and agencies, and to provide insights to help rebuild the relationship between science and society.

Throughout the pandemic, anti-vaxxers – joined by anti-maskers – have challenged scientific evidence and public health officials with a mandate to keep us safe and stop the spread of the disease. This is just one example that demonstrates society's relationship with science is under strain.

But society's relationship with science and innovation did not decline overnight. The governance model that underpins Canada's relationship with science is based on a report called *Science: The Endless Frontier* (1945). This report outlined a basic compact in which society supports science with public funds and assures the scientific community a great deal of autonomy in exchange for the considerable but unpredictable benefits that can flow from the scientific enterprise.

Today, many of the underlying social, economic, and political assumptions in the postwar compact are outdated. This project examines the relationship between science and society and begins to imagine a new relationship, through nine specific themes:

- Equity, Diversity, and Inclusion;
- Global Research Collaboration and Infrastructure;
- Inclusive Innovation;
- Indigenous and Other Ways of Knowing;
- Interdisciplinary Collaboration;
- Mission-driven Research and Innovation;
- Science Communications, Outreach, and Public Engagement;
- Skills and Knowledge; and,
- Trust, Integrity, and Science Ethics.

Taken together, these themes suggest elements of a new governance framework for science and innovation in Canada that embraces our current social, cultural and political realities, that recognizes the opportunities and limits of science. Perhaps most importantly, the project reinforces the role of science as part of society, and a tool ready to serve the needs of society.

Findings of the GSINN initiative were developed as a result of extensive research and engagement that included: a hindsight exercise, multiple foresight workshops, eight multisectoral roundtable discussions, and expert consultations that fed into this collection of 10 papers (one for each of the themes above and one capstone paper). Each discussion paper has been peer reviewed and explores a facet of how the relationship between government science, innovation, and society needs to be repaired in order to ensure science remains relevant in the new reality.

IOG extends its heartiest thanks to the eight federal departments and agencies that supported this work: Agriculture and Agri-Food Canada, Health Canada, Innovation, Science and Economic Development Canada, National Research Council, Natural Resources Canada, Public Health Agency of Canada, Public Services and Procurement Canada, and Transport Canada. We also wish to thank all of the individuals who participated in the workshops and roundtables whose input helped clarify and develop the project themes and findings. Finally, we want to acknowledge the following reviewers whose thoughtful feedback improved this paper: Thomas Davis, Cherif ould Hamou, Greg Huyer, Aliza Rudner, Dr. Jan Trumble Waddell, Sean Walkowiak, and Claire Zhou.

INTRODUCTION

Scientific knowledge improves everyday lives and well-being, provides solutions that address long-term societal and environmental challenges, and drives economic growth. It can guide and inform policy and decision-making leading to more robust public policies and more effective public programs. Trust and integrity are integral to the relationship between science and society. The promise of publicly funded science to deliver benefits to society rests on the integrity of the process of knowledge creation, translation, mobilization, and adaptation and the trust the public has in this process. The lack of a sufficient level of public trust in science can hinder scientific progress and have a detrimental impact on policy influence and civic engagement.

Trust and scientific integrity have become more salient issues in recent years as the research enterprise, the media landscape, and the public's interaction with information are undergoing rapid transformations brought about by digitalization and new information technologies. The scale of research has drastically altered in recent decades as the sources and amounts of funding have grown; the volume of information and data have increased exponentially; research results are disseminated more rapidly; and new research methods are increasingly complex and technical. Research is more regulated and institutionalized as new forms of research governance are adopted to manage and supervise research to ensure quality and accountability. These changes in the governance of research and the adoption of novel methods of research assessment and evaluation are re-shaping the research environment while also creating opportunities for misconduct and dubious research practices.

The rise and proliferation of social media and new structures that monetize information provide spaces for new actors with a variety of intentions and motivations to flourish, create space for more people to engage on global issues and challenges such as climate change, and create greater opportunities for lifestyle changes, e.g., access to clean technologies. The emergence of these factors enables misinformation to abound, and challenges the public's engagement with science, both the ability of legitimate actors to reach them and their ability to distinguish between legitimate actors and those with less than noble intentions. The pandemic has also brought about new challenges for public trust in science as people look to scientists for quick solutions and to governments to develop and deliver adequate responses in a highly uncertain and risky environment.

In this paper, we analyze the relationship between public trust and scientific integrity and the key challenges that are re-shaping this relationship. In the following sections we look at how these concepts are defined, how definitions vary in scientific and policy discourses, and how these concepts are translated into codes of conduct. Next, we discuss some of the major challenges that impact the level of public trust in science and present findings from a roundtable discussion with subject matter experts from eight federal departments. We conclude with a set of questions to guide further discussion on how public trust in science can be strengthened and a culture of scientific integrity sustained in the face of these challenges.

THE IDEAL OF A VALUE-FREE SCIENCE

The ideal of science as a value-free endeavor devoted to the objective interpretation of facts presumes that science is autonomous from society. This ideal has been central to the stature of science in society and accords science with legitimacy and integrity (Lacey, 2004). The principles of impartiality and neutrality of science are considered the cornerstones of good science and the reason for the prestige and trustworthiness of science. According to this ideal, science is immune to undue influences and scientists perform their work independently. Matters of value exist outside of the realm of science and the results that scientists arrive at are objective and unswayed by their personal interests and values.

This understanding of science as value-free has been questioned by philosophers, political scientists, sociologists, and scientists. It rests on the distinction between *epistemic* and *non-epistemic* values (Douglas, 2009; 2021). Larry Laudan (1984) describes the former as attributes that "represent properties of theories which we deem to be constitutive of 'good' theories"; social or ethical values are characteristics deemed constitutive of a "good society" (Laudan, 1984). Science is not value-free because the scientific method is imbued with values such as truth, empirical adequacy, and explanatory scope. These are epistemic values or values constitutive of scientific practices that guide how science is done and validated. In addition, other broader societal, political, and moral values (or non-epistemic values) also shape the choices that are made by scientists when they are doing their work. These values often come into play when decisions are being made on what knowledge claims to accept or reject, what standards of evidence to accept, and how the science is to be applied. And they are very much prevalent when scientific evidence is an input for policy formulation.

Transparency about values that play a role in their work is important for scientists involved in government and the policy process. This acknowledgment does not imply relativism in the choices that are made or that the presence of values is indicative of unsound science, nor does it necessarily undermine public trust. In fact, transparency about the broader societal and ethical values that play a role in scientific decision-making can preserve the integrity of science and sustain public trust in science (Elliott and Resnik, 2014). While some studies have shown that public trust in scientists decreases when scientists acknowledge their influences and reveal their values; this correlation is dependent on whether these values are shared by the public and the kind of work the scientists are doing. Public trust increases if scientists acknowledge their values while making policy recommendations but decreases if values play a role while assessing the state of the science (Dietz 2013; Elliott et al. 2017). This has implications for government scientists who work at the interface of science and policy.

THE SCIENCE-POLICY INTERFACE

While the role of values in science is now widely acknowledged, there is a lack of agreement regarding how these epistemic (constitutive) values and societal values interact and the role that societal values play in scientific practices. Elliott (2017) argues that societal values can be incorporated into science through transparency, representativeness, and engagement. Values that influence scientific work can be identified by transparency in data, methods, and models. These values should be representative of the broader societal priorities and their influence on science should be scrutinized through wide engagement of diverse stakeholders. These practices can act to increase the level of public trust in science. The interaction between these values assumes more importance in the case of government scientists and those who work at the science-policy interface where scientific evidence interacts with societal values.

The science-policy interface has been defined as “social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making” (van den Hove 2007). Scientists employed in government play several roles at this interface. Gluckman (2018) has identified four such roles. These roles include *knowledge generators* or the scientists who produce knowledge; *knowledge synthesizers* or the scientists who integrate knowledge from different sources and make sense of it; the *knowledge brokers* or scientists who act as translators conveying science to policymakers and the needs of policymakers to scientists, and finally, *policy evaluators*. Gluckman borrows the term “broker” from Roger Pielke, Jr.’s book, *The Honest Broker* (2007). While advocates argue for a particular outcome, brokers “transmit the knowledge in an appropriate, reasonably values-free way— because it can never be absolutely values-free— to the policy community, allowing them to overlay the values dimensions they have responsibility for” (Gluckman 2018).

In Canada, another group of scientists who play an important role at the policy interface are those who deliver Related Science Activities (RSA). While Research and Development (R&D) activities generate new knowledge that can be used to innovate, RSA activities or tasks include data collection, maintaining collections and data sets, feasibility studies, monitoring activities, tendering advice, drafting guidelines, and regulatory governance of risk, safety, and compliance. The federal government defines scientific R&D as "creative work undertaken on a systematic basis in order to increase the stock of scientific and technical knowledge and to use this knowledge in new applications" and RSA as "those activities that complement and extend R&D by contributing to the generation, dissemination, and application of scientific and technological knowledge".[1] RSA is often integral to policy formulation and development. It is also complex as it sits at the intersection of multi-level governance and involves knowledge sharing between different levels as it can influence local, provincial, and international regulations (Doern and Kinder 2007, Kinder 2013).

PUBLIC TRUST IN SCIENCE

Trust is a multi-dimensional relationship. Its dimensions include risk vulnerability, reliability, competence, credibility, honesty, and openness among others. Hon and Grunig (1999) define trust as a relationship that has three dimensions: "integrity, the belief that a person or organization is fair and just; dependability, the belief that a person or organization will do what they say; and confidence, the belief that a person or organization has the ability to do what they say they will do" (Grunig, 1999).

According to Resnick (2011), trust has numerous aspects. Trust is a relationship between people; it facilitates social interactions; it involves risk-taking and vulnerability; people trust others because they judge them to be trustworthy; and finally, trust can generate ethical and legal duties. The 2020 report of the Council of Canadian Academies lists trust as one of the core values of research integrity and defines it as "being reliable, as a person or institution, through character and action" (Resnick, 2011).

Barber in his 1987 essay on "*Trust in Science*" talks of trust as having two main aspects: trustfulness and trustworthiness. Both are integral for public trust in science. Trustfulness is "an expectation or prediction that an assigned or accepted task will be competently performed" (Barber, 1987). The person performing that task will do so proficiently based on their level of technical expertise.

Trustworthiness is "the reposing of fiduciary obligations and responsibilities in an individual or on an individual" (Barber, 1987). We trust that the person performing the task will fulfil their duty and place

[1] Statistics Canada, "Data quality, concepts and methodology: Definitions". https://www150.statcan.gc.ca/n1/pub/88-204-x/2010001/technote-notetech3-eng.htm

the obligations inherent in their role above personal interests. The public as well as the scientific community trusts scientists to follow the norms of science and fulfil their obligations to colleagues, to their institution, and to the larger public. Fraud in science and research misconduct are egregious as they violate trustworthiness.

Public trust is also nuanced, and different individuals establish this relationship of trust with science differently. The public is not an undifferentiated and homogeneous mass but form distinct groups or publics based on shared values and interests. Each group has a different trust relationship with science.

HOW IS TRUST MEASURED?

Trust is usually measured through attitudinal survey questions. The survey questions often cover both trusting behavior and trusting attitudes. There are several surveys that measure trust in government and institutions that are administered regularly allowing for trends to emerge and be analyzed. Edelman's Trust Barometer measures trust as the average percent trust in NGOs, business, government, and the media. The annual 3M State of Science Index tracks attitudes to science in several countries including Canada.

In Canada, like many other developed countries, public trust in government and in science has generally remained high. The 2020 Edelman Trust Barometer indicates that overall trust is high in Canada. In May 2020, trust in government was the highest in comparison with trust in NGOs, business, and media. Trust also increased for all news sources and was highest for traditional and owned media. The 2020 3M State of Science Index was based on two rounds of surveys: one before the onset of the pandemic and the second six months into the pandemic. Overall, science skepticism was on a decline, and trust in science and scientists had increased. The survey results indicated that scientists are most trusted sources for scientific information while social media was least trusted. People are far more likely to believe science information coming from their preferred traditional news sources (67%) than social media (27%).

People also assess scientific institutions and scientists differently from scientific principles and methods. While trust in the latter is relatively stable, trust in the former is more volatile. Distrust of scientific institutions and of the systems that regulate science and technology is often high (Achterberg et al. 2017; Burchell 2019).

FACTORS IMPACTING PUBLIC TRUST IN SCIENCE

The variables that affect public trust in science include the large volume and complexity of scientific findings, hype, inadequate science communication, science literacy and public understanding of science, and research misconduct and fraud.

The uncertainty that is a natural part of scientific findings and the abstractions that characterize scientific models are not easy to communicate effectively to policy makers and the publics. According to Fischhoff and Davis (2014), communicating uncertainty "requires (i) characterizing uncertainty, by identifying the issues most relevant to the choice; (ii) assessing uncertainty, by summarizing that information in a useful form; and (iii) conveying uncertainty, by creating messages that afford decision makers the detail that their choices warrant" (Fischhoff and Davis, 2014). Not only is communicating uncertainty difficult, but it is also delicate. Acknowledging uncertainty while communicating with the publics can avoid hype and increase public trust but since an acknowledgment of uncertainty is also a declaration of the limitations of a model, it can contribute to public skepticism (Kreps and Kriner, 2020).

Uncertainty also manifests in disagreements amongst scientists that can undermine public trust. The public look to scientists for clear answers and guidelines. The lack of consensus among scientists on an issue tends to muddy the waters leading the public to look at other sources for guidance. Scientists disagree due to many reasons. At times one or more scientists may be making an inaccurate claim due to incompetence, personal beliefs, personal interests, methodological choices, or due to the inherent complexity and uncertainty of the world (Dieckmann and Johnson 2019). The lack of consensus among scientists can undermine public trust in science especially when it is played out in the media. Disagreements and the level of incivility of the discourse can lead to a broader public mistrust of scientists and scientific methods (Chinn and Hart 2022). According to Aklin and Urpelainen (2014), "given that a very high degree of consensus is needed to achieve high levels of public trust, it is difficult for scientists to try to ''win'' the debate in the media". A better strategy would be to increase public awareness about the role of uncertainty in science and create more opportunities for public participation in the regulatory process.

The level of scientific literacy amongst members of the publics determines if people can understand the complexity of science. Scientific literacy is also used synonymously with public understanding of science. Traditionally, scientific literacy has been defined as an understanding of the norms and methods of science and of important scientific terms and concept. A third dimension – a broad understanding of the impact of science and technology on society and of the science policy process – is equally important in a context where science and society are inextricably intertwined (Miller, 1983). Scientific literacy also entails an understanding of the limitations of science (Jenkins, 1994). A greater level of science literacy in the population helps to temper people's expectations of science and, without unrealistic expectations of science, they will most likely have greater trust in science (Laugksch, 1999).

Research and scientific misconduct including plagiarism (using or representing the ideas, processes, or words of others as one's own work), falsification (changing, omitting, or manipulating of research results to support claims and hypotheses), and fabrication (making up data and observations that never occurred and reporting them) severely undermine public trust in science. These cases of fraud in science often receive widespread publicity in the media (and Canada has not been immune). Existence or perceptions of conflicts of interest also lead the publics to doubt science or increase public skepticism of scientists (Krimsky, 2003).

The proliferation of sophisticated technologies such as AI and the use of algorithms and machine learning in sectors ranging from healthcare to human resources management are also shaping the public's relationship with science, technology, and systems of governance. The widespread adoption of AI poses several challenges such as reinforcing unfair biases, discrimination, privacy infringements, and manipulation of political systems. These challenges raise concerns among the public about the trustworthiness and effective regulation of these new technologies. A recent study by KPMG and the University of Queensland (2021) comparing public trust in AI in five countries (Australia, Canada, Germany, UK, and USA) found that more than a third of the participants were unwilling to trust AI systems in general and about a third reported ambivalence. 83% of the Canadian participants viewed AI regulation as required and 70% of Canadians perceived a great deal of uncertainty around the impact of AI on society. Trust is challenging when it comes to AI largely due to the lack of transparency and explainability of the use of algorithms and complex analytics. But it is compounded as people make value-based judgements about the role and impact of AI on their lives and on society (Ingrams et al., 2021).

The changing media environment with the decline of print and the rise of social media and new structures to monetize information has also affected the trust relationship between the publics and science. While public trust surveys indicate that social media is a less trusted source than traditional news media, it is often the source that people turn to for their news. Social media suffers from what Wardle (2019) calls information disorders including: "disinformation (content that is intentionally false and designed to cause harm), misinformation (false content shared by a person who does not realize it is false or misleading), and malinformation (genuine information that is shared with an intent to cause harm)" (90). Misleading or downright false reports on scientific topics can increase public skepticism of science and erode public trust in science. A way forward is to create well informed publics by promoting media literacy so that individuals can critically understand and discern the sources, techniques, strategies, and impacts of media messages, content, platforms, and products.

Media reporting on science veers between the two extremes of hyperbole and failures. Most newspapers and owned media no longer have dedicated science reporters with the level of scientific literacy to effectively report on science and technological developments. The exaggeration or misrepresentation of scientific findings by the media contributes to public mistrust as expectations are belied in the long term. Retracted studies often get media attention, but the media does not cover the causes of retraction which often are due to reasons other than fraud. Neither do they cover the consequent efforts to address the issue. Often the publics are bombarded with conflicting messages and headlines regarding scientific findings. This has an impact on the public understanding of science as well as on public trust in science for these reports often fail to convey the reliability of science (Ophir and Jamieson, 2021).

Hype or the extensive use of superlatives distorts expectations about scientific developments, and oversimplifies the potential impacts of science, the time in which the impact of science may be realized, and the scientific process itself. If those expectations are not met it may lead to a loss of public trust in science. There is increasing tendency to exaggerate research results and present them in extremely positive terms (Morris et al, 2021; Ball, 2015). A growing tendency of self-promotion among scientists (Morris et al, 2021) in turn informs a certain level of hype is common in science communication as it can generate political support and secure funding. Yet too much hype and promotion becomes a questionable behavior. These include instances where benefits are overemphasized and risks underplayed or when hype is used to influence policymakers to divert funding towards certain research areas or if it leads to a premature push to commercialization (Morris et al, 2021; Master and Resnick 2013).

The rise of social media, changes to media reporting, hype and related concepts are explored in greater detail in the GSINN discussion paper on Science Communication, Outreach and Public Engagement.

THE CONCEPT OF SCIENTIFIC INTEGRITY

The postwar social contract for science argued that the science community's internal accountability mechanisms (peer review, etc.) embody the principal ethical responsibilities of the system; any abuses are merely a "housekeeping" problem (Sarewitz, 1997). Therefore, it was argued that the system should maximize the autonomy of the scientific community to police itself. However, scientific integrity has risen to prominence in recent years as cases of scientific misconduct and fraud came to light casting doubts about the ability of the scientific community to self-govern. Recent media reports raise concerns about scientific integrity in Canada (Semeniuk, 2021).

Like public trust, scientific integrity is a multi-dimensional concept and eludes a concise definition. The concept of scientific integrity is integral to scientific methods, research cultures, and to science policy. In policy discourses, scientific integrity is seen as fundamental to public trust in institutions and government. Not only does the absence of scientific integrity in policy making lead to unsound and bad policies, but it also has more serious repercussions on the relation between science and society for it can undermine public trust in scientists as well as support for science-informed policy.

Scientific integrity covers the entire research lifecycle from formulation of a research problem to the dissemination of results and their mobilization and adaptation. The concept is embedded in institutional research cultures, rooted in geographical contexts, and integrated with broader policy cultures. As such, the concept has a distinct national or regional character. Resnick and Elliott (2019) distinguish between two broad understandings of scientific integrity, outcome integrity and process integrity. Outcome integrity pertains to the attainment of goals of science while process integrity relates to conformity to the norms that promote those goals. Not only are there varied definitions and standards of scientific integrity, but also different procedures and understandings of whose responsibility it is to uphold these standards (Horbach and Halffman, 2017). The definition of scientific integrity, what it is and what it is not, shapes its governance.

The definitions of scientific integrity range along a spectrum. At one end are narrow definitions that view scientific integrity in terms of serious acts of research misconduct such as falsification, fabrication, and plagiarism (FFP) while on the other end, scientific integrity is viewed as a broader concept that encapsulates responsible research practices, sound scientific methods, and ethical conduct. This broad conception of scientific integrity blends into science ethics (Steneck 2006). Martinson et al. (2005) expand the list of research misconduct beyond FFP to include 16 additional instances of misconduct or "questionable research practices" such as ignoring aspects of human-subject requirements, repeat publications, questionable interpretation of data, using inappropriate research designs, inadequate record keeping, and inappropriate assignment of authorship credit. The Tri-Agency framework on responsible conduct of research characterizes a number of actions as breaches including FFP, destruction of research records, redundant publication or self-plagiarism, invalid authorship, inadequate acknowledgement, mismanagement of conflict of interest, misrepresentation in a grant application or related documents, mismanagement of grants or award funds, breach of agency policies or requirements for certain types of research, and breach of agency peer review processes (CIHR et al. 2016).

At the other end of the spectrum, the definitions of scientific integrity are fuzzier. Scientific integrity is framed not in terms of misconduct or questionable research practices but in terms of ethical practices and behavior. As such, the rules become unclear, and it is difficult to know if any breaches of the rules or standards have occurred. Narrower definitions that focus on actions that constitute breaches of scientific integrity lead to context-specific strategies oriented to formulating clear rules and sanctions for breaches; while broader definitions that view scientific integrity as a matter of ethics lead to a focus on training that emphasizes universal scientific values (Godecharle et al., 2013). It is important not to treat scientific integrity as synonymous with the ethics of scientific research; while, the former focuses on norms, rules, and procedures, the latter is a much broader domain that includes actions, the principles underlying the actions, and the purposes guiding the actions (Patrão Neves, 2018).

Adopting a different approach, de Vries et al. (2006) focus on the perspective of scientists and the kinds of behaviors that scientists describe as concerning. While FFP are serious matters, they are rare. They found that the scientists were more concerned about the mundane issues in their working lives and their transgressions such as: “(1) the meaning of data, (2) the rules of science, (3) life with colleagues, and (4) the pressures of production in science” (44). Examples of these “normal misbehaviors” include “the difficulty of finding the line between cleaning data and cooking data” (45); ignoring certain rules due to the overwhelming number of rules and regulations that must be followed; inaccurate record-keeping; lack of clear responsibilities in a collaboration; authorship issues; unreported conflicts of interest; and stealing ideas from grant proposals. These “normal misbehaviors” arise from the way science is organized and the demands that a competitive research culture places on scientists. Questionable research practices arise from the “great tension between what researchers should do to advance science, and what they had to do to be successful” (Bonn and Pinxten 2021). Any debate about scientific integrity must consider the current context within which science is done.

GOVERNMENT SCIENTISTS

Scientists working in government are bound by public service codes of conduct and by codes of ethics pertaining to research and scientific integrity. Government scientific integrity policies are based on the principle that science, free from any undue influence, should inform policy making. And if a policy decision is made contrary to the available scientific evidence, science should not be manipulated to support the decision (Union for Concerned Scientists, 2017).

In their analysis of discussions of scientific integrity in scientific and policy documents, Horbach and Halffman (2017) find that scientific integrity is framed differently by the science community and by policy makers. The concept has been defined more consistently with the same set of components in the scientific literature while policy documents emphasize different aspects over time. While the scientific community views scientific integrity as a virtue to be nurtured and developed by individual scientists and the scientific community, policy makers focus on detecting cases of scientific misconduct and enforcing norms and standard of scientific integrity. Scientists are concerned about the promotion of good science in scientific publications and correct assignment of authorship, and their focus is on values, sound research methods, and promoting scientific integrity. Policy documents, on the other hand, focus on misbehavior or bad practices in research, their detection, and punitive sanctions. These differences have implications when codes of conduct are transformed into standards and policies as the latter may not connect with the key concerns of scientists and the broader research culture. In such a situation, compliance becomes formal and is just another set of check boxes to tick off.

The federal government's model Science Integrity Policy (mSIP) (GoC, 2021) defines scientific integrity as "the condition resulting from adherence to concepts of transparency, openness, high quality work, avoidance of conflict of interest and ensuring high standards of impartiality and research ethics." It is a broad definition that covers the entire gamut of research activities from research design to science communication and extends to the use of science. While avoiding research misconduct forms the core of scientific integrity, the policy also includes protecting scientists' ability to communicate directly with journalists and the publics including public access to the science, prohibiting censorship, commitment to sound science as a basis for decision making, transparency about scientific integrity complaints and violation, whistleblower protection, and codification of policies into law. The policy outlines a two-pronged approach that combines developing a culture of scientific integrity and responsible conduct of research with oversight and reporting requirements. "The first focuses on instilling the virtues that underlie responsible conduct in research, science, and related activities (s. 7.2.1) while the second focuses on the procedure for bringing allegations of breaches forward, the investigation of these allegations, and the consequences of a finding that a breach has occurred (s. 7.2.2)."

The challenges that lie ahead include harmonizing provincial and federal policies, sorting issues entangled between different codes of conducts (such as consistently protecting scientists' ability to communicate directly with journalists and the publics), applying the policy to all agencies and programs, formulating agile procedures that can respond to additional ethical issues emerging with new technologies, and establishing checks and balances in the investigation process, oversight mechanisms, and appeals procedures.

CURRENT CONTEXT

There has been a shift in recent years from a focus on individual integrity and individual cases of scientific fraud to analyzing scientific integrity in the context of the organization of research. While this approach analyzes scientific integrity as a systemic issue, it also focuses on how organizations translate the concept into standards and structures (e.g., departmental policies) and enforce them. This broader focus has helped to identify how changes to the research environment are contributing to an increased incidence of scientific misconduct as well as creating opportunities for fraud or unethical practices to game the system.

Digitalization and new technologies; changes in research governance, resource allocations, and incentives; increasing corporate influence on science; and the increased reliance on metrics including the development of new measures for evaluating research excellence have resulted in fundamental shifts in the way research is structured and carried out. Scientific misconduct and other questionable research practices occur not to bolster an individual's research profile but to enhance their organization's reputation. This kind of manipulation is distinct from traditionally defined misconduct because it is not about manipulating data or research results but is concerned with institutional valuation (Biagioli et al. 2019). Instead of a rogue scientist acting alone to enhance their prestige, several institutional actors collude in these unethical acts to build organizational reputation.

The spread of an "audit culture" across organizations has led to an increased emphasis on productivity metrics for evaluating scientists, research outputs, and organizations (Power, 1999). These metrics are used to make high stake decisions such as promotions and funding. The increasing reliance on metrics for evaluating research excellence and measuring research impact has led to novel ways to game the system. According to Biagioli (2016), these new impact metrics signify a shift from "publish or perish" to "impact or perish". Groups of authors or journal editors connive to cite each other's work to increase citation counts and journal impact factors. These new forms of fraud are not concerned with manipulating the content of the publication but are "post-production manipulations" pertaining to the measurement of impact to enhance the evaluation of impact (Biagioli and Lippman, 2020). The group of actors involved includes not just researchers and scientists but also journal editors and publishers, conference organizers, and university administrators.

Other questionable organizational practices that harm scientific integrity include the growth of predatory journals and dubious conferences. Predatory journals and publishers are not invested in the gate-keeping and peer review roles of traditional journal publishers. They prioritize self-interest over scholarly communication and quality of scholarship. These journals may include misleading information and dubious research. There is a lack of transparency about their review and editorial processes, and they indiscriminately solicit research articles with no consideration of research quality (Grudniewicz, 2019). Since new metrics are constantly being developed, novel methods of manipulation are constantly emerging requiring concomitant changes in the norms and standards of scientific integrity.

Another emerging discussion in the Canadian science and research landscape is taking place where Western science and Indigenous and Other Ways of Knowing are braided together to promote Reconciliation with Indigenous Peoples and self-determination through research. Each of these knowledge systems has a distinct culture and practices. These cultures place different priorities on certain epistemic and non-epistemic values which determine what and how research is conducted, what and how data is collected, stored, and by whom it may be accessed. These different practices stem from different concepts of and attitudes regarding the conduct of science and research. A number of initiatives are underway – in the public service, the Tri-Agency, and among academe – to find ways to develop mutually acceptable and respectful practices that promote research and scientific ethics and integrity across these different knowledge systems.

FINDINGS FROM TWO IOG ROUNDTABLE DISCUSSIONS

In March 2021, the Institute on Governance hosted a half-day workshop on Trust, Integrity, and Science Ethics. Subject matter experts from eight federal departments – Agriculture and Agri-Food Canada, Health Canada, Industry, Science and Economic Development Canada, National Research Council of Canada, Natural Resources Canada, Public Health Agency of Canada, Public Services and Procurement Canada, and Transport Canada – participated in the discussion. The workshop employed the seven-question foresight methodology to explore the theme of trust, integrity, and science ethics.

One year later, in March 2022, the IOG hosted another half-day workshop on Trust, Integrity and Science Ethics. The eight departments and agencies listed above worked together to identify a group of their departmental stakeholders from the public, private and civil society sectors to review an earlier draft of this paper and to consider the implications of the theme for their work, and their relationship with one or more departments listed above.

The topics raised by workshop participants during the discussion demonstrate close alignment with academic literature on this subject. Any repetition between previous sections and this one only serves to illustrate this alignment.

Workshop participants noted four important factors that are external to (or at least, in part, beyond the control of) government:

- **All scientists are the same, wherever they work**. Workshop participants noted that a conversation about trust, integrity, and science ethics should be extended beyond the federal government. As one participant said, "the public [doesn't] make much of a distinction between scientists housed in government versus universities and the private sector…questions of trust, integrity, and ethics are equally dependent upon the actions of scientists [inside and] outside of government."
- **Scientific literacy**. There is broad concern about a perceived decline in scientific literacy among the portion of Canada's adult population that doesn't work in a scientific field. In this case, science literacy was extended to concepts of familiarity with science, an understanding of the scientific process, and a culture and practice of asking questions about science and debating or discussing topics in order to improve one's own understanding of (scientific) issues. Workshop participants reflected on current practices in public secondary education where science courses are only mandatory until grade 9, noting curriculum design is a responsibility of provincial governments. The group also noted that many NGOs exist to

engage children and young adults in science – such as Let's Talk Science – but the participants were not aware of any which target adults (except through their children). Is there a role for a dedicated source of unbiased, scientific information with an objective to improve science literacy among Canadian adults? Is a declining lack of scientific literacy among Canadian adults contributing to a lack of deference to (scientific) authority?

- **The infodemic**. A proliferation of misinformation and disinformation on social media perpetuated by low media literacy rates provides platforms for anyone to share their opinion as fact and contributes to an increasingly confusing world in which many people struggle to distinguish between real and fake news. The pandemic has not caused this infodemic but has created "a perfect storm on steroids" for many who already felt lost and overwhelmed in a more cluttered media landscape that presents additional challenges for journalists and government spokespersons – each of whom operate according to a code of ethics – who seek to promote accurate, reliable information.

- **Passive data collection.** Everywhere we turn, devices and companies are collecting our data. The purpose for which our data is collected is not always clear, nor transparently stated, nor do citizens always understand for how long their data will be stored and used. There is increasing concern around the misuse of data (using data for a purpose for which it was not expressly collected), and a growing call for a conversation around consent to collect, store and use data. This raises questions about how we govern data retroactively. At the same time, there is a need to navigate how different ways of knowing conceptualize what is data, how should it be collected, used, stored, and accessed.

Workshop participants discussed the role of effective science communications – a challenge that is particularly acute for the federal public service during the pandemic and points, potentially, to a need for collaboration across all levels of government. Participants noted that effective science communications is as much about the findings as it is about communicating the scientific process, which is especially true for the government's regulatory functions. Many such functions – such as food inspection, regulating medical devices – take place without a high degree of public engagement or understanding, nor a concerted effort to promote that role of the government when doing so could build trust with citizens. Yet the rationale for regulatory science is clear, and were these functions communicated to citizens, it might create an opportunity for teachable conversations about science and the scientific process.

Effective communication is also about using language that is meaningful for the intended recipients, without oversimplifying the messages nor encouraging the acceleration of reactions to sensitive topics. Scientific findings – especially during the pandemic – are constantly changing as new information, new studies are being released in pre-publication format. The rapid pace of new knowledge generation in turn prompts regular revisions to policies, directives, and protocols. The schedule of these changes is not consistent across levels of government, nor clear to the public. These decisions – seemingly based on the “same science” may inform very different types of decisions based on other factors – demographics, economics, risk, etc. – yet lack the transparency to communicate the role that each factor takes in the decision made.

Participants discussed a number of ways to socialize the culture and practice of science in order to have it become ‘a mainstream’ component of the federal government culture, rather than an exclusive or intimidating subculture. Owing to the composition of workshop participants, these ideas focus on improving the relationship between science and policy, pending further research, these ideas could be extended to other parts of the federal public service (e.g., services, programs, communications, corporate services).

The ideas and recommendations range in scope and scale, and collectively, support a move towards increasing transparency of the use of scientific evidence in decision making, not just when an unpopular decision is taken so it can be ‘blamed’ on science, and in a way that future-proofs decision making to weather changes in political leadership. (This idea of blaming unpopular decisions on science is an idea that arose several times and indicates perceived tensions between science and policy functions in the public service and between the public service and political leaders.)

- **Learning from past pandemics.** On the positive side, workshop participants noted the federal government is implementing lessons it learned during the SARS epidemic.
  - Too many spokespeople during SARS confused the public. During COVID, many federal and provincial governments have maintained a single or pair of spokespeople to promote continuity and build trust.
  - Science literacy increased during SARS, on topics directly related to that virus. Government messaging should evolve with the public’s understanding of the pandemic, reflecting an understanding of growing knowledge and comfort with the subject.
  - What humans know about SARS CoV-2 is constantly changing. Public scientists need to talk as much about the new information and what it means as they must do about the scientific processes that lead to the new information. This also means embracing a level of uncertainty about the latest information and being clear about what it does mean and what it doesn’t mean, to bring Canadians along in the decision-making process.

Workshop participants offered the following suggestions to promote a science-friendly culture inside the federal government.

- **A consistent approach to science advice**. The federal government could benefit from a consistent approach to delivering scientific advice, and how science is communicated. Several participants suggested the Office of the Chief Science Advisor – leveraging the Departmental Science Advisor (DSA) network – has a role to play to revitalize, formalize and standardize models for collecting, evaluating, and providing scientific advice in the federal public service. A new model might extend to academia when expertise does not exist inside the federal public service, as was effectively employed through the CanCOVID Network. As a component of offering science advice in a consistent manner – and going where the expertise lives – workshop participants see merit in removing the hierarchical approach that stop people communicating directly with some people higher up (and across) in the food chain. Expand access to senior management for junior people and require people at a senior level to be open to receiving hard messages from their subordinates could improve how science travels around the public service.

- **Identify ways to improve collaboration and collegiality of scientists** across the whole of the public service. For example:

    - Create an HR tool to quickly deploy scientists from one department to another for time-sensitive projects (e.g., during the pandemic)

    - Introduce Research Ethics Boards in all departments and agencies where research involving humans takes place. Establish a mandatory process to incorporate ethical decision making in government. Such a process could require consultation of Research Ethics Boards or science.

    - Consider creating a cadre of scientists that are more externally-facing, and willing to engage external publics via social media and citizen science initiatives. These scientists would require a more diverse skill set and perspective than traditional classifications of scientists.

- **Build stronger bridges between science and policy** across all federal departments and agencies

    - Co-located scientists and policy analysts

    - Design multi-disciplinary tiger teams for special projects

- Incentivize scientists to take short term assignments in policy roles
- Increase participatory research, stakeholder, and patient engagement across all departments to improve/expand considerations for policy making

CONCLUSION AND DISCUSSION QUESTIONS

The past two years have been challenging for the relationship between science and the publics[2]. Science and scientists have occupied a very public role in policy making and the publics were looking for definitive answers and guidance from scientists to deal with the Covid-19 public health emergency. Data uncertainty, escalated research timelines, and the need to get information out quickly compounded the uncertainty that is normal to science. Research results were shared and communicated before scientists had reached a consensus and the science was settled (or even before peer review had occurred). The explosion of pre-prints and their uptake in media were a response to the urgency to address the public health challenge. While the circulation of pre-prints ahead of publication is a common practice to get feedback from colleagues, in this instance they led to dissemination of results that were unverified but became a part of the policy discourse. The pandemic has exposed the publics to the messy ways of doing science and the often long process of achieving consensus.

The pandemic emerged in a world that was already dealing with the fallouts of political hyperpartisanship, populism, and post-truth. As Kakutani (2018) describes in *The Death of Truth*, in this world the value of truth is diminished by "(…) a disregard for fact, the displacement of reason by emotion, and the corrosion of language" (12). This lack of heed for facts was fueled by the easy accessibility and circulation of misinformation and disinformation and proliferation of social media. Changes in recommendations, conflicting testimonies, and retractions occupied center stage in the never-ending cycles of news reporting and ubiquitous social media. These factors may have a long term impact on the level of public trust in science and scientists. The lessons of past epidemics indicate that the current pandemic may affect perceptions and attitudes towards individual scientists and weaken the belief that their activities benefit society (Aksoy et al. 2020).

In 2017, a scientific integrity consortium that included representatives from Canadian and U.S. government agencies, professional societies, universities, and nonprofit scientific organizations developed a set of best practices for scientific integrity (Kretser et al., 2019). These include training

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[2] The term publics is used intentionally to underscore that Canadians are not one large monolithic public, but that Canadians represent a diversity of groups with different views, perspectives, and information needs.

scientists in sound robust scientific methods, appropriate experimental design, and responsible research practices; strengthening oversight; promoting transparency to encourage research reproducibility; establishing open science; teaching effective communication skills; strengthening the peer review process; reforming publishing practices including processes for correction or retraction of published papers; and developing comprehensive evaluation criteria that reward scientific integrity. While these are sound recommendations, strengthening scientific integrity is not sufficient to prevent the erosion of public trust in science. Current times require sustained relationship-building between scientists, policy makers, media, and the publics.

DISCUSSION QUESTIONS

- How can scientists communicate trustworthiness? How can scientists use new technologies to engage with the publics in innovative ways and build trust? What are ways other than directly communicating with the publics to build and maintain public trust in science?
- How can we improve science literacy and strengthen public knowledge about how science is conducted?
- What are best practices to foster a culture of scientific integrity within institutions? How can diverse stakeholders like scientists, government, universities, granting councils, and academic journals come together to promote a culture of scientific integrity? If scientific integrity is essentially an issue of trust, can integrity be policed and by whom?
- How well does the model science integrity policy connect with the daily focus and practices of government scientists? As a government scientist, how do my scientific integrity responsibilities and obligations to the broader scientific community align or conflict with my responsibilities and obligations as a public servant?
- What are some of the changes in research practices and processes that you anticipate in the coming years that will impact scientific integrity and public trust?

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