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Positive but not uncritical: Perceptions of science and technology amongst South African online users

Public perceptions of science and technology (S&T) have been measured globally since the 1970s. While there are initial findings for South Africans' general and specific perceptions of S&T, we aimed to give an update on those perceptions, and account for the recent rise of digital media and broad public discussions on S&T-related issues (e.g. COVID-19) that might have affected public perceptions of S&T. We conducted an online survey with a sample of South African online users, quoted for sociodemographic characteristics, in November/December 2020 ($n=1624$). The findings show that, even with the rise of digital media and during the pandemic, a majority of respondents in this sample agreed that S&T holds promise, and they supported governmental funding of science. However, some reservations persisted. Gender and education did not affect these attitudes. It was rather age, location, degree of religiosity, interest, knowledge, use of sources of information, online engagement, and trust in science that were linked with these attitudes. In this sample, agreement to public funding of science correlated with beliefs in the promises associated with S&T as well as with having reservations about S&T.

Significance:

- Our sample of South African online users agreed more to promises associated with S&T than they had reservations about S&T.
- Attitudes regarding S&T-related promises and reservations varied by age and location, and showed links with the interest in, knowledge about, use of sources of information on, and online engagement with S&T.
- Having reservations about S&T was nonetheless linked with support for governmental funding of science.
- The findings also indicate that social media were highly relevant sources of information about science for this sample of South African online users, who generally had high levels of interest in, knowledge about, and trust in science.

Introduction

Research into public perceptions of science and technology (S&T) has a long tradition; such research has been conducted around the globe since the 1970s.¹ 'Perceptions of S&T' is a broad term that summarises measures of attitudes towards, interest in, knowledge about, trust in, and use of sources of information about S&T.²⁻⁵ Research in this area is relevant because of the belief that national competitiveness depends on S&T-related innovation¹, which requires a supportive public. Researchers were afraid that, with rising scepticism towards science, there would be cuts in (governmental) research funding, because it requires legitimacy.⁶ Therefore, the development and pioneering of public perceptions of S&T studies in the USA⁷ were in line with testing a theoretical approach for which the evidence is mixed⁸: interest in and knowledge about science supposedly affect attitudes towards science. Positive attitudes, in turn, affect support for government spending on science.¹ Public perceptions of both science in general and specific scientific fields may affect acceptance, success, or failure of applications based on science.⁸ Thus, public perceptions affect political decisions (e.g. regulations).⁹

Consequently, measuring public perceptions of S&T is a regular activity in many countries¹, including the USA¹⁰ and some European countries¹¹. Initial findings for South Africa can be separated according to general perceptions regarding S&T^{2,12-14} (which broadly ask about perceptions of *science*) and perceptions of specific fields of science such as climate change^{15,16}, biotechnology⁹, nuclear technology and energy¹⁷, or several so-called controversial scientific fields (e.g. evolution, fracking, and traditional healing methods) in comparison⁸. However, the last quantitative update on South Africans' general perceptions of S&T dates to 2013. In the following years, global research on public perceptions of S&T has started to focus on the crisis regarding public trust in science.^{7,18,19} This is often discussed due to the increasing influence of digital sources of information, predominantly sources on the Internet, especially on social media.^{20,21} Furthermore, with the global protests around climate change and the COVID-19 pandemic^{22,23}, issues regarding S&T are debated openly in public. There are indications that this may affect public perceptions of S&T positively.²⁴

Our aim in this study was to provide an update on South Africans' perceptions of S&T. Because digital media use is increasing in many countries²⁵, we conducted an online survey. As this study focused on a sample of South African online users, the limitation is that it does not account for the general South African public. However, in 2022, almost 70% of South Africans were online users; globally, South Africa is the nation with the most daily time spent on the Internet.²⁶ The results reflect the perceptions of South African online users when the number of COVID-19 infections were slowly starting to rise in the second wave of the pandemic.

Public perceptions of S&T, with a focus on South Africa

The belief that a knowledgeable and literate public would have more positive attitudes towards S&T and its public funding, has spurred many investigations into public perceptions of S&T.^{4,7,27} However, previous surveys and their theoretical assumptions have been criticised.^{5,28} For a long time, research in this area followed deficit-model approaches (under the paradigms of science communication called 'scientific literacy' and 'public understanding

of science'). These studies assumed that people lack knowledge of, and thus, have negative attitudes toward science. These negative attitudes supposedly make them sceptical about public funding of science.⁷ Following these (rather causal) assumptions, the solution put forward was to provide more education to enhance literacy, and to emphasise the positive aspects of science.⁵ While there is some limited support for the assumptions made⁶, researchers argue that the picture is more complex.²⁹ For example, under the current paradigm ('science and society' or 'public engagement with science'), research focuses on the enhancement of trust in science.⁷

Among the global research into public perceptions of S&T^{1,10,11}, only a few studies have focused on South Africa. Researchers emphasise that South Africa has a unique fingerprint when it comes to general perceptions of S&T.¹³ This unique fingerprint relates to the fact that while there is much belief in the promises associated with S&T, at the same time, many South Africans remain reserved about it. Even more significant: the more South Africans believe in the promises, the more reservations they have about S&T. This is in stark contrast to other countries.¹³ *Promises* are defined as positive expectations and beliefs related to the benefits of S&T; *reservations* refer to predispositions and beliefs in the negative consequences of S&T. Most South Africans are also positive about specific scientific fields, even if they are controversial.⁸ Comparisons that span from 1999 to 2013 show that for South Africans, beliefs in promises regarding S&T have dropped slightly, whereas reservations about S&T have increased.^{13,14} Furthermore, these attitudes are affected by the age and education levels of survey respondents. For instance, young respondents believed more in the promises associated with S&T and had more reservations about it, than mature respondents.¹³ Location also seems to affect attitudes towards S&T.^{2,30}

Research has also established that South Africans seem to have a moderate interest in S&T, are not very well informed about it, and use traditional journalistic media such as television, radio, and newspapers to assess information about S&T.¹⁴ Scientific literacy (i.e. factual knowledge) and the use of information sources are linked positively to both assessments of promises and reservations.¹² However, studies focusing on perceptions of specific scientific fields hint at the fact that South Africans may be less informed about these fields, compared to respondents from the developed world.⁹ Yet, awareness, for instance regarding climate change, seems to have increased¹⁶, and knowledge regarding COVID-19 is high³¹, although not equally so across age and location categories²³. In a segmentation study, six South African publics, with respect to perceptions of S&T, were identified.² While all publics agreed more to the promises associated with S&T than had reservations, there were some differences between the publics (e.g. regarding media use and distance to science³⁰).

Study context and research questions

While initial findings on general and specific public perceptions of S&T in South Africa reveal interesting insights, they do not account for current trends in science communication. In recent years, in many countries, the Internet, including social media, has become the main source of information about S&T for large parts of the public.^{25,32} The Internet is also gaining popularity among the South African public.¹⁴ Researchers believe that through the rise of digital media, although they may have some advantages for science communication²⁰ overall, it became more likely for audiences to be exposed to sceptical, contested, or false information about S&T than before²¹. The reasons for that range from more opportunities for direct communication, and increasing participation and interaction, to more individualised communication patterns³³, which can have both positive and negative effects. At the same time, traditional intermediaries of information on S&T, such as journalists, are under pressure.^{34,35} Hence, the rise of digital media potentially affects perceptions of S&T. For instance, the use of digital media may have been especially relevant during the COVID-19 pandemic. It was found that more than half of South Africans used news websites and news applications to inform themselves about COVID-19, but almost half also used WhatsApp or social media²³, and thus information that was not (necessarily) mediated by professional (journalistic) norms and values.

Based on this, we aimed to report on public perceptions of S&T during the rising importance of digital media and a global health pandemic. Consequently, our first research question was:

RQ1: How do online users in South Africa perceive S&T?

We used the broad term 'perceive' to link to perceptions of S&T, looking at attitudes towards, interest in, knowledge about, trust in, and use of sources of information about S&T. Despite a potential rise of disinformation on social media, international research indicates that at the beginning of the COVID-19 pandemic, people viewed science and scientists much more positively than before the pandemic.²⁴ Furthermore, as research – globally and in South Africa – has already established that attitudes depend on sociodemographic information², we also studied to what degree attitudes towards S&T vary by gender, age, level of education, and geographical location. Thus, we asked:

RQ2: To what degree do attitudes towards S&T vary by gender, age, level of education, and geographical location for online users in South Africa?

Previous research suggests that perceptions are linked in distinct ways^{1,8}, although the direction of causal relationships cannot be clearly determined⁹. To give further explanations about the correlations between the defined variables of perceptions, we also asked:

RQ3: How are the different variables of perceptions of S&T correlated for online users in South Africa?

Methods

Research design and sample description

We conducted an online survey throughout November until early December 2020. Therefore, our fieldwork was carried out during the second wave of the COVID-19 pandemic; new infections were stable in early November but started to pick up again later that month. Survey respondents were recruited via an online access panel of almost 250 000 South Africans, provided by the external marketing research company *Ask Afrika*. This panel comprised respondents (of more than 18 years of age) in South Africa who had access to the Internet and who were invited to participate in the survey through a post about the research study on the panel portal. This means that among the members of the online access panel, anyone interested in the survey was able to participate. Nevertheless, the following quotas were considered: gender, age, province, population group, and geographical setting (e.g. urban, rural). While the statistics of South Africans who are online may not mirror census statistics for the country, we used quotas to reach a sample that came as close as possible to the overall demographics of South Africa. Invited members of the panel participated voluntarily: they signalled their informed consent, had the option to withdraw at any time, and remained anonymous throughout answering survey questions. The study received ethical approval from Stellenbosch University.

The final sample comprised 1624 participants. Table 1 provides an overview of the sociodemographic information. Compared to the overall statistics for South Africa³⁶, data are skewed towards female and mature respondents. Some provinces were overrepresented, while others were underrepresented. We also note an overrepresentation of white individuals and an underrepresentation of black individuals. The data are also skewed towards highly educated individuals and those familiar with science. Finally, there was a dominance of individuals from urban settings. These differences may be accounted for by having used an online survey²³, but in general, there is little information about the characteristics of online users in South Africa²⁶. Hence, the findings presented here are indicative rather than representative.

Measures

The survey was designed to capture all relevant aspects of public perceptions of S&T and could be completed in 15 minutes. It was available only in English. Respondents first reported their gender, age, province, population group, and geographical setting, to check the quota plan.

Table 1: Sociodemographic information (frequencies, percentages)

		The sample for this study		Mid-year population estimates 2020 ³⁶
		n	%	%
Gender	Female	913	56	51
	Male	711	44	49
Age ^a (this study: M=34.17; SD=11.235)	18–24	387	24	23 ^b
	25–34	541	33	26
	35–44	367	23	20
	45–54	231	14	13
	55+	98	6	18
Province	Western Cape	225	14	12
	Eastern Cape	132	8	11
	Northern Cape	15	1	2
	North West	65	4	7
	Free State	80	5	5
	KwaZulu-Natal	312	19	19
	Gauteng	559	34	26
	Limpopo	138	9	10
Population group	Mpumalanga	98	6	8
	Black	1185	73	81
	White	213	13	9
	Coloured	162	10	8
Location	Indian/Asian	64	4	3
	Urban, formal settlement	1170	72	–
	Urban, informal settlement	182	11	–
	Rural or tribal	272	17	–
Education	Never attended school, attended primary school, or finished with the Grade 9/GET phase	75	5	–
	Matric certificate	525	32	–
	College certificate	336	21	–
	Tertiary (university) education	688	42	–
Religiosity (this study: M=3.80; SD=1.242)	Not religious	243	15	–
	Undecided	277	17	–
	Religious	1064	67	–
Household income	Up until ZAR5000	279	17	–
	ZAR5001–10 000	249	15	–
	ZAR10 001–20 000	381	23	–
	ZAR20 001–30 000	255	16	–
	ZAR30 001–50 000	237	15	–
Familiarity with science	More than ZAR50 000	141	9	–
	Studied science at school	1004	62	–
	Met a scientist at least once personally	917	57	–
	Never worked in science	1157	71	–

^aValues of the mid-year population estimates 2020 were recoded to exclude persons younger than 15

^bIn the estimates, this refers to ages 15–24

To assess attitudes towards S&T, we used standard items developed and tested (inter)nationally.^{4,13,14,37,38} Three items measured reservations about S&T (the first three items in Table 2), three items measured promises associated with S&T (next three items), two items measured benefits of S&T, one item asked for religious beliefs, and one item captured the agreement that the government should fund scientific research.

For creating a promise and reservations index, we used items similar to those used in initial research^{13,14}, despite the notably weak reliability scores (promises: $\alpha = 0.67$; reservations: $\alpha = 0.45$) that were also reported by Reddy et al.¹³ For all 10 items, we asked for an agreement from 1, 'strongly disagree', to 5, 'strongly agree'. We added one more item to assess respondents' thoughts about the overall influence of science on society and the world, on a 5-point rating scale from 1, 'very negative', to 5, 'very positive'. All items were rotated randomly.

Table 2: Descriptive statistics for attitudes (promises and reservations)

	M	SD	Agreement %	Disagreement %
1. It is not important for me to know about science in my daily life. (R)	2.64	1.57	33	53
2. Science makes our way of life change too fast. (R)	3.96	1.19	69	14
3. We depend too much on science and not enough on faith. (R)	3.56	1.36	54	22
Reservation index	3.38	0.96	47	28
4. S&T is making our lives healthier, easier, and more comfortable. (P)	4.10	1.05	74	9
5. Because of S&T, there will be more opportunities for the next generation. (P)	4.11	1.20	74	12
6. Benefits of science are greater than any harmful effects. (P)	3.64	1.21	56	16
Promise index	3.96	0.89	72	11
7. Most scientists want to work on things that will make life easier.	4.31	0.93	83	5
8. With the application of science and new technologies, work will become more interesting.	4.22	1.02	79	8
9. Whenever science and religion conflict, religion is always right.	3.19	1.49	45	33
10. Scientific research should be funded by the government.	4.25	1.05	78	7
11. Do you think that the overall influence of science on society and the world is positive or negative? ^a	4.07	0.91	75 (positive)	4 (negative)

Notes:

n = 1485–1601

Rating scale from 1 'strongly disagree' to 5 'strongly agree'

Agreement refers to the proportion of people who chose response option 4 or 5; disagreement to those who chose 1 or 2

^aScale from 1 'very negative' to 5 'very positive'

For interest in and knowledge about S&T (Table 3), we asked for science in general, scientific methods used to generate knowledge, and COVID-19 as a scientific topic, respectively.^{4,11} We used 5-point rating scales: for interest from 1, 'not interested at all', to 5, 'very interested', and for (self-assessed) knowledge, we asked how much respondents thought they knew about science, from 1, 'nothing', to 5, 'a great deal'.

For sources of information about S&T, we incorporated traditional (journalistic) media, a variety of online media, other places to come into contact with science (e.g. science centres, botanical gardens), and interpersonal conversations. We only included specific online sources if respondents stated that they used online sources at least rarely. The set of items was inspired by other research studies^{14,38,39,40}, extended to account for the rise of digital media. For each of the sources, on a 5-point rating scale from 1, 'never', to 5, 'very often', we assessed how often respondents heard about science from each source.

Table 3: Descriptive statistics for interest in and knowledge about science

	Interest in ^a				Knowledge about ^b			
	M	SD	High interest %	Low interest %	M	SD	High knowledge %	Low knowledge %
Science in general	4.05	1.11	71	10	3.75	1.04	59	11
Scientific methods to generate knowledge	4.07	1.06	74	9	3.57	1.10	53	17
COVID-19 as a scientific topic	4.10	1.14	74	10	3.74	1.11	61	15
Index	4.08	0.89	76	10	3.69	0.93	58	17

Notes:

n = 1596–1612

^aRating scale from 1, 'not interested at all', to 5, 'very interested'

^bRating scale from 1, 'nothing', to 5, 'a great deal'

Percentages reported as 'high interest/knowledge' refer to the proportion of people who chose response option 4 or 5; low interest/knowledge, compared to those who chose 1 or 2

Table 4: Descriptive statistics for online engagement and trust

	M	SD	High online engagement/ trust %	Low online engagement/ trust %
How often do you ^a				
Seek scientific information via online search engines such as Google	4.05	1.06	71	9
Rate (e.g. through likes) online content about science (e.g. online newspaper articles, blog posts, videos on video platforms, posts on social networking sites)	3.27	1.18	42	26
Comment on online content about science (e.g. online newspaper articles, blog posts, videos on video platforms, posts on social networking sites)	3.06	1.25	35	34
Share content about science published by others online (e.g. on social networking sites or retweeting)	3.20	1.22	39	28
Publish own content about science online (e.g. writing blog posts, on social networking sites or tweeting)	2.44	1.38	24	57
Index online engagement	3.20	0.97	37	32
How would you rate your trust in science ^b	3.97	0.97	72	7

Notes:

n = 1559–1610

^aRating scale from 1, 'never', to 5, 'very often'

^bRating scale from 1, 'do not trust at all', to 5, 'trust a great deal'

Percentages reported as 'High online engagement/trust' refer to the proportion of people who chose response option 4 or 5; low online engagement/trust to those who chose 1 or 2

The survey also captured online engagement with science (Table 4), by asking respondents how often they sought scientific information via search engines, how often they liked, commented on, or shared content about science, and how often they published their own content about science⁴¹, on a 5-point rating scale from 1, 'never', to 5, 'very often'. Furthermore, we asked if they trusted science⁴, also on a 5-point rating scale from 1, 'do not trust at all', to 5, 'trust a great deal'.

For testing the links between variables, we computed indices: interest in science ($\alpha = 0.74$), knowledge ($\alpha = 0.82$), use of sources of information ($\alpha = 0.91$), and online engagement ($\alpha = 0.85$). For assessing links between variables, we decided to report on correlations, but not to test causal assumptions. We made this decision in the light of theoretical and methodological criticism of previous research⁵ and because there is no succinct model for the causal links between variables in the perceptions of S&T framework¹.

Results

Perceptions of S&T

Regarding RQ1, Table 2 displays (dis)agreement to statements measuring promises associated with and reservations about S&T. Among the reservation items, most respondents agreed that science makes our way of life change too fast, and more than half thought that we depend too much on science and not enough on faith. At the same time, more than half disagreed that it is not important to know about

science in daily life. Regarding promises, almost three quarters agreed that S&T is making lives healthier, easier, and more comfortable, and that because of S&T, there will be more opportunities for the next generation. More than half also agreed that the benefits of science are greater than the harmful effects. In total, more respondents showed agreement to the promises associated with S&T than to reservations about it.

Furthermore, almost half of the respondents agreed that whenever science and religion conflict, religion is always right. However, a third of the respondents also disagreed with this statement. In addition, respondents showed a high degree of agreement to the statements that most scientists want to work on things that make life easier, that research should be governmentally funded, that with the application of S&T, work will become more interesting, and that the overall influence of science is positive.

From Table 3, respondents reported a high degree of interest in science in general and scientific methods to generate knowledge, as well as in COVID-19. A similar picture appeared with respect to knowledge.

The respondents used a variety of sources to receive information about S&T (Figure 1 displays all 21 sources considered). Among traditional media, fictional content in movies, books, or series and television were used most often, followed by non-fiction books, print magazines and newspapers, as well as radio. Online sources were used most often. Among the different online sources considered, most respondents used online video platforms such as YouTube, followed by websites of scientific institutions, and online wikis.

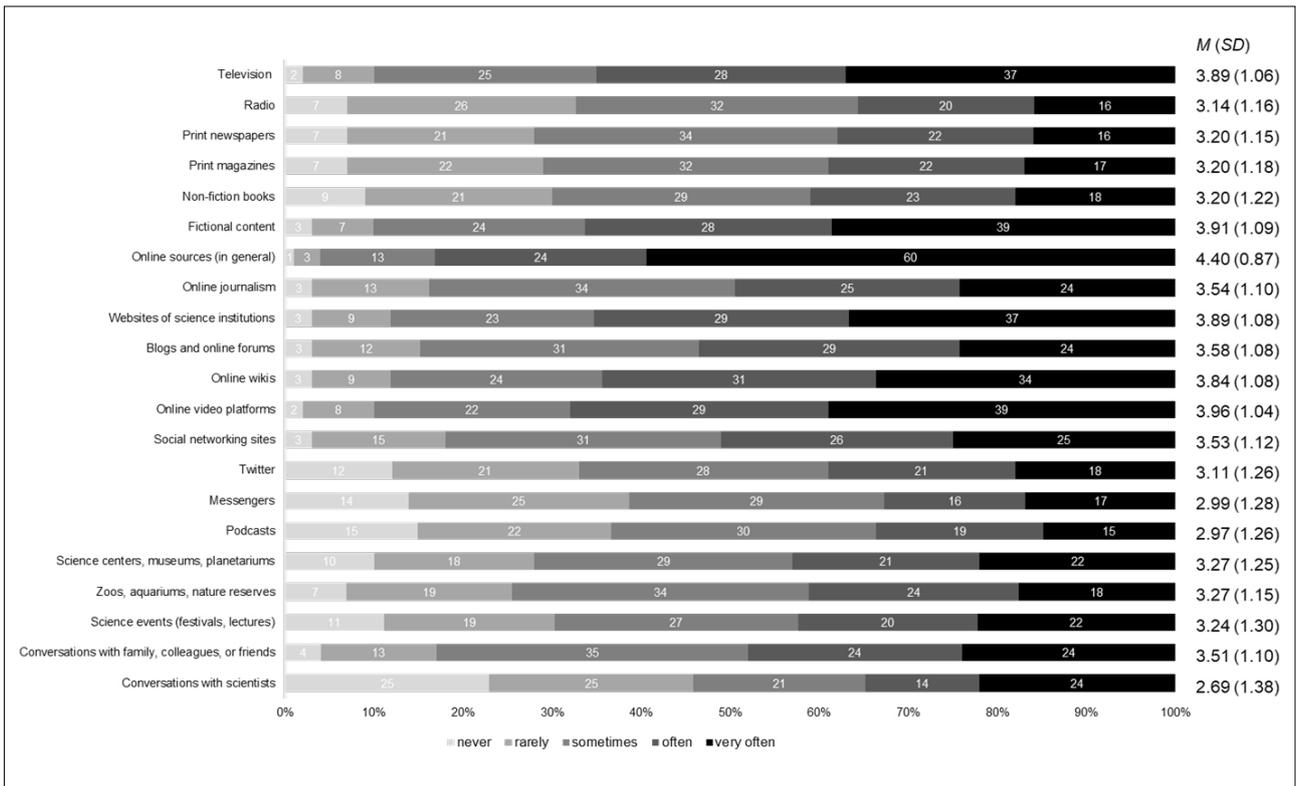


Figure 1: Sources of information about science for a sample of South African online users.

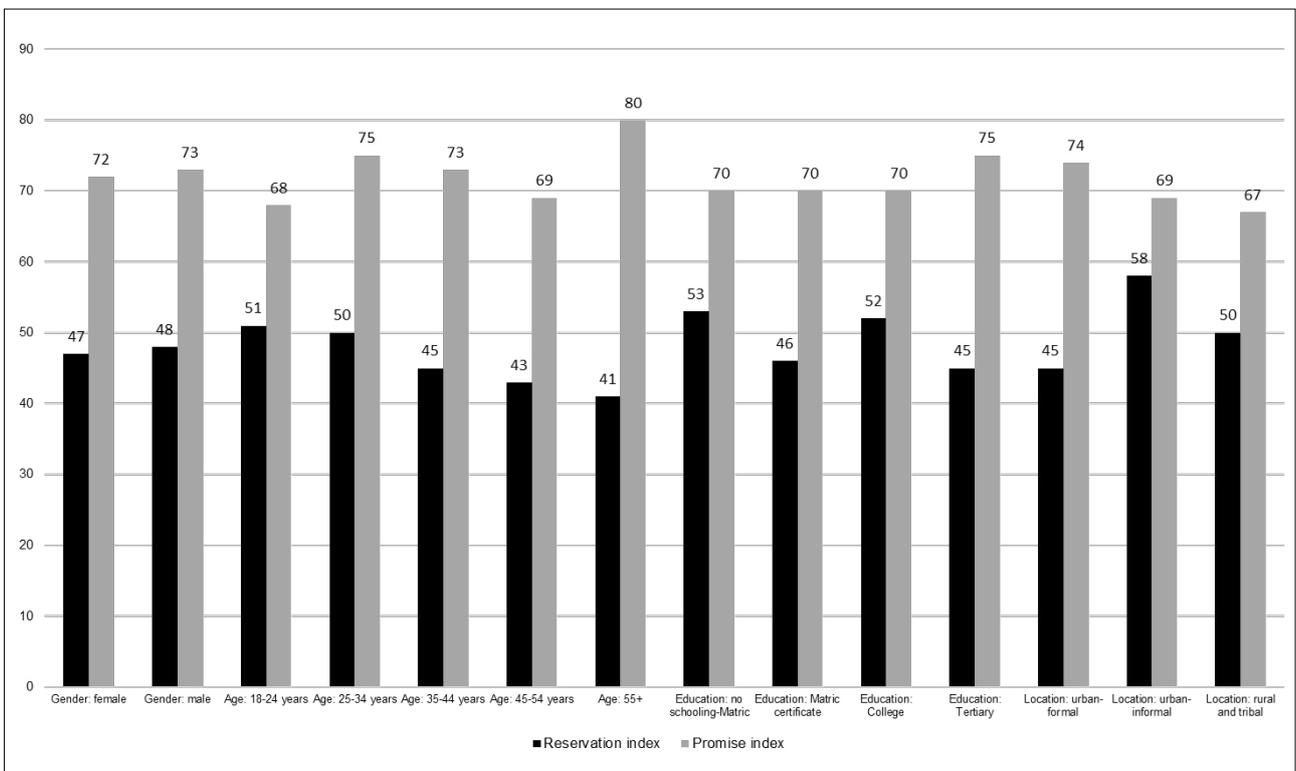


Figure 2: Promises of and reservations about science and technology by gender, age categories, educational level, and geographical location.

Many respondents also used blogs and online forums, social networking sites such as Facebook or Instagram, or journalistic websites or applications of newspapers or broadcasters, which included live and on-demand services. Fewer respondents used Twitter, or messenger applications such as WhatsApp or Facebook Messenger, or podcasts.

As there are other ways to receive information about S&T, we also asked about science centres, museums, planetariums, science events such as science festivals, science cafés, public lectures, and expert discussions, as well as zoos, aquariums, nature reserves, and botanical gardens. However, these sources were relevant for only some respondents. Conversations with other people such as family members, colleagues, and friends were quite common, but conversations with scientists were the least often considered source of information about S&T.

In addition, the participants showed a high degree of online engagement with science for seeking scientific information via search engines, a moderate degree of engagement for rating (e.g. liking), commenting, and sharing on the Internet, especially on social media, and only a low degree of engagement for publishing their own content about science (Table 4). Their trust in science was rather high.

Variations in attitudes by sociodemographic information

Figure 2 displays how promises and reservations vary by gender, age, educational level, and geographical location (RQ2). We did not observe differences for gender: both male and female respondents agreed more to promises associated with ($t(1514)=-1.20$; d.f.=1512; $p=0.23$) than had reservations about S&T ($t(1533)=-0.09$; d.f.=1531; $p=0.93$). However, we did observe that age had a clear effect: reservations ($F(1533)=4.78$; d.f.=4; $p<0.001$) were highest among the young, and lowest in the mature groups. At the same time, belief in the promises associated with S&T ($F(1514)=4.01$; d.f.=4; $p=0.003$) was lowest among the young and highest among the mature category. Regarding educational level, we did not observe a difference across the groups for promises ($F(1514)=2.27$; d.f.=3; $p=0.08$) and reservations ($F(1533)=0.43$; d.f.=3; $p=0.74$). Figure 2 nevertheless indicates that the difference between promises and reservations was highest for those with tertiary education. Location did affect attitudes towards S&T: reservations ($F(1533)=12.43$; d.f.=2; $p<0.001$) were the highest in urban-informal settings, rural and tribal settings, and lowest in urban-formal settings. Belief in promises ($F(1514)=4.25$; d.f.=2; $p=0.014$) was the highest in urban-formal settings and rural and tribal settings, and lowest in urban-informal settings.

Links between the variables

With respect to RQ3, we tested for links between the variables considered (Table 5). We found, firstly, that perceptions of promises associated with and of reservations about S&T correlated weakly but positively, which indicates that belief in the promises did not mean that respondents did not

also have reservations. Secondly, for reservations about S&T, we found the highest correlation with the item probing that whenever science and religion conflict, religion is always right. Reservations about S&T also correlated with interest and knowledge, as well as the use of sources of information, and online engagement. Furthermore, there was a weak correlation between reservations and supporting governmental funding of science. This shows that having reservations is not the same as being sceptical towards science or not supporting public spending on science. We did not observe significant correlations between reservations and the item that the overall influence of science is positive or trust in science, respectively. Thirdly, promises associated with S&T did not correlate with the item measuring religious beliefs, but we found significant relationships for all other items tested. The correlations were always higher for the promises than for the reservations index. As such, promises were correlated with a perception that the overall influence of science is positive, with trust in science, with interest and knowledge, as well as using sources of information, and online engagement. As expected, belief in the promises associated with S&T was correlated with supporting the funding of science. Fourthly, the variables tested showed further correlations, of which the ones between interest and knowledge are noteworthy, as well as using sources of information, online engagement, and trust in science. They were all positively correlated, and some indicated a strong relationship.

Discussion

Although research into public perceptions of S&T gained global popularity¹, there are only limited data for South Africa, and the last update on general perceptions of S&T dates to 2013¹⁴. The years since then have seen a theoretical shift in science communication towards the issue of trust¹⁹, the rise of digital media with both positive and negative consequences implied²⁰, and a more intense public debate about issues related to S&T²². Therefore, in this study, we aimed to present a recent update on public perceptions of S&T for a sample of South African online users.

The findings of an online survey quoted for sociodemographic information revealed that agreement to the promises associated with S&T reaches a high of more than 70%. Sampled South Africans also have reservations about S&T, but their overall agreement regarding these items is lower than 50%. Nevertheless, this indicates support for the assumption that South Africans may have a unique fingerprint¹³ in the sense that they appreciate the benefits of S&T, but also remain critical/cautious. Furthermore, the population of South African online users in this study expressed high levels of interest in and knowledge about, as well as high trust in science. Our additional questions in the case of interest and knowledge showed that agreement was higher for the assessment of the specific topic of COVID-19 than for S&T in general. In other studies, South Africans also expressed good knowledge about the pandemic.²³

A specific focus of the present study was on sources of information, for which we tested 21 different sources and further assessed online

Table 5: Correlations between the reservation and promise index and influential variables

	Reservation index	Promise index	Funding support	Religion is always right	Influence of science	Interest index	Knowledge index	Use of sources of information	Online engagement
Promise index	0.138***	–							
Funding support	0.125***	0.392***	–						
Religion is always right	0.411***	0.027	0.069**	–					
Influence of science	0.008	0.519***	0.298***	-0.031	–				
Interest index	0.095***	0.409***	0.311***	0.022	0.356***	–			
Knowledge index	0.205***	0.359***	0.221***	0.105***	0.327***	0.492***	–		
Use of sources of information	0.242***	0.348***	0.247***	0.128***	0.307***	0.458***	0.613***	–	
Online engagement	0.219***	0.354***	0.201***	0.114***	0.332***	0.420***	0.627***	0.726***	–
Trust in science	0.046	0.429***	0.244***	-0.029	0.449***	0.416***	0.510***	0.407***	0.415***

Notes:

n=1293–1582

Numbers in bold indicate moderate or strong correlation effects.

engagement with science. As we used an online sample, it may not be surprising that most respondents used online sources and social media platforms. What is interesting, though, is that respondents also made use of a variety of traditional, journalistic, and other media, and even places to come into contact with science, as well as interpersonal communication. We do acknowledge that the frequencies of receiving information about S&T may have been affected by the pandemic. For instance, people may have visited science events less frequently due to government regulations, but may have used other media more frequently. Engagement with science online took on different forms. For this sample, it was more common to search for scientific information on the Internet than to rate, comment, or share scientific information. Only a few respondents reported publishing their own content about science. This more active behaviour supports that journalism no longer has a monopoly as science information provider.³⁵ Online users sampled here relied on a variety of different sources. Yet, even though we used an online sample that relied heavily on many different sources of information, some of them more regulated than others, in comparison to other studies^{13,14}, we did not find lower agreement to the promises associated with, or higher agreement to reservations about S&T. This may be an indicator of rather stable beliefs. Hence, compared to surveys in other countries that show that perceptions of science and scientists became more positive during the COVID-19 pandemic²⁴, we did not (yet) see a similar effect for South Africans in our sample. Part of the reason could be that the last update on South African perceptions of S&T comes from 2013 and this issue would need more (continued) research.

In our sample, there was additional support for the observation that promises associated with and reservations about S&T in South Africa do not vary by gender. However, we found differences in age, as was indicated by the research literature.¹³ While previous research shows that promises and reservations are highest among the youngest, in our sample, individuals of mature age believed more in the promises than had reservations. Previous research also indicated that level of education affects attitudes towards S&T¹³, but we found no clear support for this. However, the sample was skewed towards educated respondents. Location affected attitudes towards S&T in ways similar to those expressed in Guenther and Weingart². Those in informal and tribal/rural areas seem more distanced from science than people in urban settings.

Furthermore, in this sample of South African online users, we observed a weak and, interestingly, positive correlation between beliefs in promises associated with and reservations about S&T. Thus, having reservations should not be interpreted as science scepticism, as support for governmental funding of science was widely agreed upon, even when respondents held reservations. This is, in fact, what makes researchers state that South African samples have a unique fingerprint.^{12,13} In our sample, we nevertheless identified that reservations were correlated with religious beliefs, with almost half of the respondents deciding in favour of religion when science and religion are in conflict. We also saw that, although correlations between promises, interest, and knowledge, as well as using sources of information, online engagement, and support for science funding were higher compared to the correlations of these factors with reservations, these correlations were also found for reservations about science. It may be argued that the link between these factors is stronger for respondents with stronger beliefs in promises associated with S&T, but it also existed for those who had reservations. Similarly, both promises and reservations correlated with media use, although correlations for promises were stronger. The link between media use and the other variables from the perceptions of S&T framework is worthy of further investigation. We also found that trust in science only correlated with promises associated with S&T, but not with reservations about S&T. Hence, trust might be linked to promises, but at the same time, we did not find indications that a lack of trust would be linked to reservations in this sample.

In summary, the sample of South African online users in this study agreed more to promises associated with S&T than reservations about it. Recent trends in science communication – such as the increasing importance of online sources of information that are often not regulated by professional norms and values – as well as the COVID-19 pandemic, make research into perceptions of S&T all the more relevant. Naturally, the present study has limitations. These relate to the use of an online survey, in English, which made it less likely for some parts of the

population to participate.²³ The online sample used in the present study was not representative of the general South African population; it does not capture the sizable proportion of South Africans who do not use the Internet and it was based on an online access panel. However, an impact of digital media might be best assessed using an online survey, and we used quotas to achieve a satisfactory sample. Methodologically, some items we used are criticised⁵; but at the same time, they offer the opportunity to make comparisons over time. This also relates to the low scale reliability of the promise and reservations index.

Future research should explore some of the findings of the present study more deeply; for instance, the link between religious beliefs and reservations⁴², or the link between trust in science and promises. Table 5 also reflects correlations deserving further exploration regarding the (causal) relationships between variables in the public perceptions of S&T framework.¹ Because researchers now recognise that the public is not a uniform entity, but comprises different publics with distinct attitudes towards S&T^{10,43}, for instance affected by their world views²⁸, future research should conduct segmentation analyses. With the rising importance of digital media²⁶ and an ongoing pandemic, questions on how South Africans think and feel about S&T and what factors affect their attitudes, will be of high priority in the future. Because in this study we looked only at perceptions of S&T in general, future research should include specific scientific fields, for instance perceptions related to virology and the COVID-19 pandemic.

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Competing interests

We have no competing interests to declare.

Authors' contributions

L.G., A.R., M.T. and P.W. conceptualised the study, collected the data and took on project leadership and management; L.G. and A.R. analysed the data; L.G. wrote the initial draft; and A.R., M.T. and P.W. revised the manuscript.

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