# Evaluating expectations from social and behavioral science about COVID-19 and lessons for the next pandemic

**Author List 1**: Kai Ruggeri, Alex Haslam, Valerio Capraro, Paulo Boggio, Naomi Ellemers, Aleksandra Cichoka, Karen Douglas, David Rand, Sander van der Linden, Mina Cikara, Eli Finkel, James N. Druckman, Michael Wohl, Richard Petty, Joshua A. Tucker, Azim Shariff, Michele Gelfand, Dominic Packer, Jolanda Jetten, Paul Van Lange, Gordon Pennycook, Ellen Peters, Katherine Baicker, Alia Crum, Kim Weeden, Lucy Napper, Nassim Tabri, Jamil Zaki, Linda Skitka, Shinobu Kitayama, Dean Mobbs, Cass Sunstein, Matteo Galizzi, Katherine Milkman, Marija Petrović, Jay Van Bavel, Robb Willer

**Author List 2:** Friederike Stock, Anna Louise Todsen, Ali Hajian, Sanne Verra, Vanessa Buehler, Maja Friedemann, Marlene Hecht, Rayyan Mobarak, Ralitsa Karakasheva, Markus Tünte, Siu Kit Yeung, R. Shayna Rosenbaum, Žan Lep, Yuki Yamada, Sa-Kiera Tiarra Jolynn Hudson, Lucía Macchia, Irina Soboleva, Eugen Dimant, Sandra Geiger, Hannes Jarke, Tobias Wingen, Jana Berkessel, Silvana Mareva, Lucy McGill, Francesca Papa, Bojana Većkalov, Zeina Afif, Eike K. Buabang, Marna Landman, Felice Tavera, Jack Andrews, Aslı Bursalıoğlu, Zorana Zupan, Lisa Wagner, Joaquín Navajas, Marek Vranka, David Kasdan, Patricia Chen, Kathleen R Hudson, Lindsay Novak, Paul Teas, Nikolay Rachev

## Abstract

Social and behavioral science research proliferated during the COVID-19 pandemic, reflecting the substantial increase in influence of behavioral science in public health and public policy more broadly. This review presents a comprehensive assessment of 742 scientific articles on human behavior during COVID-19. Two independent teams evaluated 19 substantive policy recommendations ("claims") on potentially critical aspects of behaviors during the pandemic drawn from the most widely cited behavioral science papers on COVID-19. Teams were made up of original authors and an independent team, all of whom were blinded to other team member reviews throughout. Both teams found evidence in support of 16 of the claims; for two claims, teams found only null evidence; and for no claims did the teams find evidence of effects in the opposite direction. One claim had no evidence available to assess. Seemingly due to the risks of the pandemic, most studies were limited to surveys, highlighting a need for more investment in field research and behavioral validation studies. The strongest findings indicate interventions that combat misinformation and polarization, and to utilize effective forms of messaging that engage trusted leaders and emphasize positive social norms.

**Introduction**

The global COVID-19 pandemic that began during the Winter of 2019-2020 has taken more than 6.5 million lives around the world in its first two and a half years[1]. As of this writing, over 600 million people, including residents of every continent, have tested positive for the disease, with many countries only recently reopening borders or loosening restrictions following as many as 24 months of lockdowns, quarantines, and other drastic measures to slow virus spread. The disease has upended life around the world, necessitating extraordinary measures by individuals, governments, and institutions[2–4] and impacting economic[5], social[6], and psychological well-being[7].

Because the virus moves from person to person through direct and indirect contact, attempts to minimize spread necessarily involved efforts to modify many seemingly innocuous, everyday behaviors. In the earliest days of the disease, these included warnings about washing hands[8], reducing proximity to others[9], touching public surfaces[10], and minimizing trips outside the home[11]. As evidence on transmission dynamics improved, recommendations shifted more precisely to not only wearing masks, but also making sure masks fit properly[12], and ensuring the type of mask being used was effective[12]. As further evidence emerged, behaviors of interest expanded to include testing[13], adhering to isolation guidelines when positive[14], getting vaccinated[15], and getting booster shots to maintain levels of immunity[16]. Thus, encouraging behaviors that would limit disease spread and discouraging those that would accelerate it has been central to effectively fighting the virus[17] at every stage of the pandemic. However, even when broadly supported, producing policies and public health guidelines are alone not a panacea, given both public responses and shifting dynamics during a public emergency[18–20].

At the beginning of the pandemic, 42 academics from eight countries and multiple academic disciplines presented a series of hypotheses about managing collective behavior during the pandemic[21]. This paper generated unprecedented attention and impact in the psychological and social sciences. The article highlighted research on a range of domains studied by social and behavioral scientists, including threat and risk perception, social norms, science communication, emphasizing individual and collective interests, leadership, stress, and coping. In only two years, the published version had over 3,000 citations and an Altmetric score in the highest 0.0001% of all articles ever published as of June 2022. Government decisions around the world implemented behavioral concepts covered explicitly[22] in the paper into many of the pandemic policy strategies[23–29].

Naturally, with such levels of visibility, concerns were also raised about various aspects of the article. Broadly speaking, social and behavioral scientists viewed the pandemic as a critical target for experts to invest their time[30] and research[31]. However, some criticisms of the sudden interest from social and behavioral scientists emerged directly related to academics who had not previously worked on pandemics making recommendations[32,33], drawing claims of opportunism, of focusing too much on evidence from WEIRD (Western, Educated, Industrialized, Rich, Democratic) populations, of overstating the validity of existing evidence, and insufficiently emphasizing heterogeneity of effects found for some interventions[34–37]. As such, it is important to evaluate the quality of the claims to inform theorizing about behavior during the COVID-19 pandemic as well as potential relevance of these claims for future pandemics and public health emergencies.

Concerns related to the readiness or robustness of evidence for application to policy are neither new nor unique to COVID-19. Terms such as "evidence-based policy" have long been presented as an appetitive framing for idealistic approaches to major decisions in government, institutions, schools, and

businesses[38]. However, there is no consensus approach to what counts as sufficient evidence to make public policy decisions[39]. This is a particular problem in an emergency, when urgent decisions must be made with modest evidence and policymakers may seek the lowest-risk or most-effective approach rather than a perfectly-informed one[40]. As such, the COVID-19 pandemic presents an opportunity to implement a method to identify and assess evidence, and employ a framework to encourage more such evaluations of academic policy recommendations.

There are now more than two years of research to evaluate where behavioral insights about the pandemic have been supported by evidence. In line with this, we provide a robust evaluation of highly influential claims from the Van Bavel et al. article (see first column in Table 1 from this paper for the full list of predictions we evaluate). We present a comprehensive, pragmatic method for assessment of behavioral policy recommendations, covering 19 statements about potentially relevant insights regarding effective responses to the COVID-19 pandemic. This is not a comprehensive evaluation of all behavioral science related to the pandemic, nor of *all* the individual statements made in the 2020 paper. However, this approach is useful for evaluating evidence-based policy recommendations broadly, particularly in public health and behavioral policy[41]. We included both original authors and an independent team of evaluators in selecting and assessing evidence relevant to these claims. Our approach leveraged the expertise of the original authors, while also adding an additional group of scholars who were not involved in the original paper to provide a more objective evaluation of the evidence.

The primary motivations for this work were to evaluate evidence for a set of claims regarding behavior during a pandemic, to create a standard for presenting and evaluating evidence that is suitable for informing public policy (both related to COVID-19 and future applications), to make those assessments public, which promotes transparency and build trust with the public[42], and to transparently assess the validity of arguments made in a highly influential report now that *ex post* evidence exists. The first and second aims are more broadly relevant across scientific research. The latter point is especially critical given substantial concerns raised about public trust in science directly related to COVID-19[43–48]. The third point is also used as a framing for assessing policy recommendations.

**Methods**

Our approach was to assess evidence related to the most central statements or hypotheses (which we refer to as "claims") in the original article. For the purposes of evaluation, we treated these claims as testable hypotheses, then rated the level, direction, and magnitude of findings relevant to each claim. We included a large number of evaluators, including authors of the original study as well as an independent group of senior and early career behavioral scientists and policymakers from multiple institutions. Their assessments focused on whether evidence available so far in the pandemic supported, refuted, or left unclear the validity of the claims (see online database for details).

*Claims evaluated*

We evaluated the ten claims highlighted in Box 1 of the original article, as well as five additional claims made in the main text. Those additional claims related to behaviors, themes, or policies that ended up being especially relevant during the pandemic, such as vaccination choices and the influence of political polarization, but which did not clearly overlap with one of the ten primary claims. It was determined that all other claim-like statements in the text were either already covered in the original 10 or were not

precise enough to assess evidence against. One of the original ten claims was treated as five distinct claims, given how it was written, creating a total of 19 claims.

*Evidence used for evaluations*

Articles and reports used for the assessment were identified through extensive systematic and manual searches by all evaluators, with the primary criterion being that they were publicly available prior to June 1, 2022. Searches included using the systematic review criteria produced by PubMED-NCBI for research specifically on COVID-19, as well as checking preprint servers, multiple repository search engines, crowdsourcing (on social media and targeted email lists), and snowballing of relevant articles (including articles that cited the original paper). There was no restriction for locations or language (see later for how the diversity of authorship enabled broader searching). This approach yielded approximately 3,000 articles initially. After removing duplicates and articles deemed irelevant to any specific claim, 742 articles were used in the initial assessment. To ensure no major studies were missed, reviewers were encouraged to search for any potential additional articles after their assessments were submitted to the lead author. Those articles had to meet the same deadline and were only included if they substantively influenced the overall assessment. One such article was identified[49], while one set of interrelated studies was updated to include both original papers, letters to editors, and responses to letters[50–52].

Our aim was identifying the highest evidence level available for each claim. We considered conducting a traditional systematic review, but we were not interested in synthesizing interventions or theories, but rather in compiling evidence related to the key claims. Therefore, we were more inclusive in reviewing evidence than would be appropriate for a meta-analysis, as studies included may have only partially informed our review. Our goal was to determine the level of the best evidence available in support of, in opposition to, or inconclusive regarding the claims.

Similarly, we asked reviewers to decide what evidence should or should not be included as part of the process. In a policy context, this means there may be disagreement over what counts or what does not, which cannot be resolved through selection criteria and extracting data alone (i.e., disagreements would still occur in setting the selection criteria). We also wanted to minimize a singular confound that might overly bias expert assessments in the same direction. Because of this approach, we do not provide a PRISMA diagram, as each reviewer had different articles they felt were or were not valid indications of evidence. Further details on this are in the supplement; limitations of the approach are in Discussion. However, all authors strongly endorse systematic reviews of individual aspects of behavior during COVID, particularly those that relate to narrowly defined behaviors and those with experimental or intervention components.

Finally, we included preprints in the review, allowing reviewers to determine the quality and robustness of material alongside material that was published after peer review. This decision was made because, for better or for worse[53], preprints were extremely visible unlike ever before during the pandemic and often treated (at least by the public) as equivalent as published articles[54]. Many preprints, though still not through peer review, routinely received considerable attention in the media.

*Metric for evaluating evidence*

The lead author on this article was chosen for experience in reviewing and reporting behavioral science in public policy contexts[55,56], particularly in public health[57], and for having coordinated large-team research[58–60], and specifically for having led the development of an evidence standard for evaluating research for policy. That standard - the THeoretical, Empirical, Applicable, Replicable, and Impactful (THEARI) system for evidence to be used in policy[61] - was produced in collaboration with academics, policymakers, and collaborators from the UN, World Bank, OECD, and NASA, and has been used by governments to assess evidence, including specifically in the context of behavioral policy[41,62].

THEARI ratings range from 1 to 5. Where no empirical evidence exists and only perspectives, opinions, or hypotheses are available, evidence level is considered a 1 (Theoretical only). Where empirical evidence exists from surveys, lab studies, or other highly controlled settings, evidence is rated 2 (Empirical). Where evidence has been produced in real-world, consequential settings (i.e., where a choice results in a non-laboratory effect, such as a genuine financial or health outcome), this is considered a 3 (Applicable). If effects from studies rated 3 are re-tested in other consequential settings, this evidence is treated as a 4 (Replicable). Finally, where substantial evidence has been produced in real-world, consequential settings in multiple contexts (even if not successful in all, but contours of effects are clear), this is considered a 5 (Impact).

THEARI ratings can be applied to individual articles as well as to wider assessments of specific claims. The primary purpose of the scale is to offer a policy-informed approach to assessing and comparing against expectations made regarding proposed interventions, which is precisely the aim of this study.

THEARI has been implemented in government policy-making related to behavioral concepts across multiple behaviors and methods[41]. While NASA has long used the Technology Readiness Level (TRL) to identify products ready for spaceflight, scientific evidence relevant to policy interventions are not products. Evidence that something was effective in one instance does not make it appropriate in all likely uses, unlike, for example, a flashlight. Consider evidence on anti-tobacco messaging: up to a certain point, messaging can be effective at discouraging tobacco use. However, after repeated messages, the effects can wane and eventually backfire[63]. Such complexity requires a broader tool for assessment, with multiple complementary dimensions. (See Discussion for future applications.)

*Evaluation teams*

Two teams were responsible for the evidence review: 33 of the original authors[21] in one team and 36 independent reviewers made up the second team. Three additional reviewers were also involved in a hybrid capacity as they were not part of the original authorship, but had produced multiple relevant behavioral studies during the pandemic. Those authors are in the first list here as they reviewed a longer list of articles for two claims that had substantially more papers than others. The use of two independent teams and a small number of hybrid reviewers was meant to minimize bias and increase diversity of perspectives. The lead author only contributed to assessments by compiling and reviewing articles identified as being "best evidence." This approach was intended to promote trust and integrity through transparency in assessment of prior work[44].

Reviewers represented institutions from more than 30 countries. Though reviewers were predominantly based in Europe and North America, there was some representation from every continent. This also allowed for searches to span more languages than English-only articles, particularly white papers and other institutional reports on interventions during the pandemic that would inform the review. Claim

assignments were held entirely confidential to reduce bias or influence, as were the names of all participating in the review (though names were visible during some training sessions, only the lead author knew claim assignments).

*Procedure*

All reviewers followed a standardized approach to assessing each of the claims. In each instance, reviewers were provided a set of articles assigned by a central team. As the volume of papers varied substantially across claims (fewer than ten were found for some; more than 100 were identified for Claim 7), reviewers had different numbers of articles to review. For the larger volume claims, some procedural adjustments were made where reviewers only assessed a subset of articles (a plan was established to address any issues created in the event someone then missed highly relevant material, but this only occurred once and was easily resolved). Each reviewer was required to read the articles in the list, noting four primary aspects:

1. Was the article relevant to the claim?
2. What was the overall level of evidence (THEARI 1-5)?
3. If there was any empirical evidence, was it in support (positive) or against (negative) the claim?
4. If there was any empirical evidence, what was the general effect size (small-medium-large)?

After reviewing all articles, reviewers were asked to produce a summary of the overall claim, covering the same four themes. However, rather than assessing individual articles, reviewers were asked to rate the overall evidence specifically based on the highest quality research available. In other words, rather than giving an average assessment of available evidence (as in a meta-analysis), reviewers rated the *best* evidence available. This procedure is more relevant in a policy context, where it is preferable to evaluate the highest quality evidence available than to estimate average effects from all available evidence. We originally intended to include inter-rater reliability, but as each reviewer only assessed one claim in most instances, there is no way to assess reliability at the claim level and assessing individual articles would be too noisy (with many missing values).

After all reviews were completed, reviewers were invited to do manual searches to identify additional relevant articles. Any articles that a) were publicly available before June 1, 2022, and b) reviewers deemed as potentially influencing the overall assessment were shared with the relevant reviewers. Authors were then invited to review and potentially update their assessments.

Evaluations were submitted centrally to the lead author; no reviewer was allowed to see other reviews. The lead author anonymized evaluations so that evaluations would be anonymous to a central coordinating team that checked evaluations for mistakes or inconsistencies (e.g., ratings that did not align with the article noted as highest evidence or with the summary statement). All material from these processes have been compiled and posted in an interactive format for public use (https://tabsoft.co/3xZwIbD).
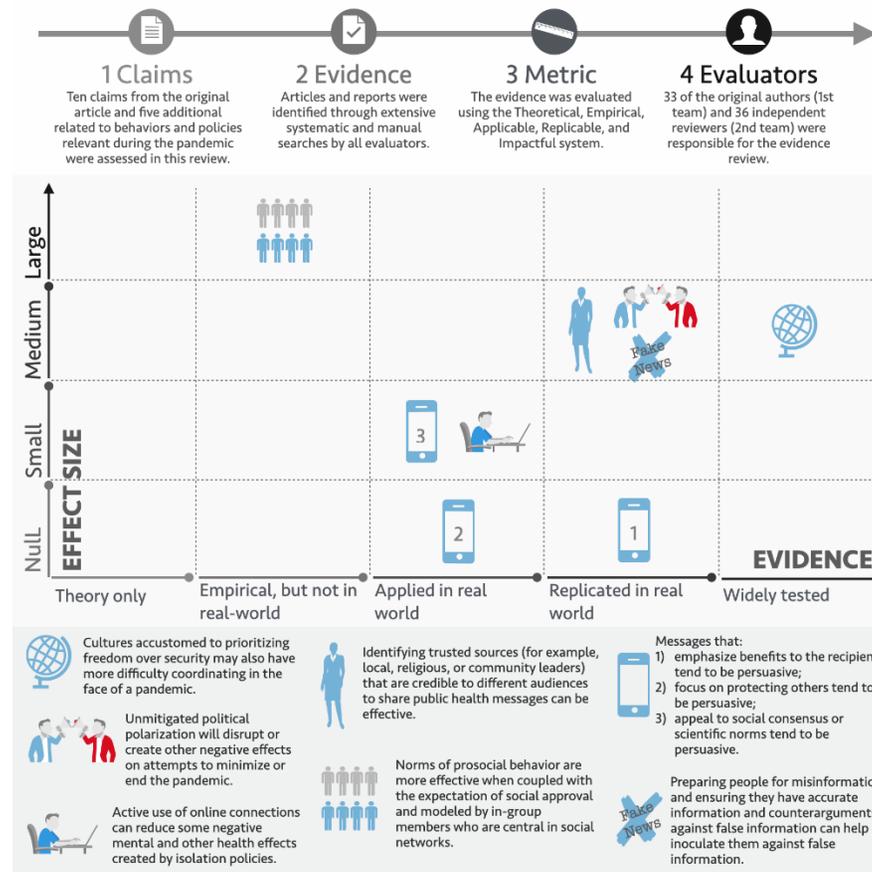
**Figure 1.** Summary of the THEARI evaluation process (top) and selected findings (bottom) from reviewing 19 claims on social and behavioral science. The x-axis present the average effect size for each claim and the y-axis present the THEARI rating (from Theory only to Widely tested). Each cose set of claims is represented by a different icon. Most claims were confirmed with small to medium effects applied or replicated in real world contexts. The strongest effect was for social norms, but most research in this domain had not yet been applied outside experimental contexts.

**Table 1.** Nineteen claims about social and behavioral science during COVID, using 2020 and 2022 wording.

| 2020 Claim wording | 2022 Claim wording |
|---|---|
| 1. A shared sense of identity or purpose can be encouraged by addressing the public in collective terms and by urging 'us' to act for the common good. | There is a small positive association between collective identity and behavior for common good, but the relationship depends on the level of identity activated (e.g., nation vs. EU). |
| 2. Identifying trusted sources (for example, local, religious, or community leaders) that are credible to different audiences to share public health messages can be effective. | Identifying trusted sources (for example, local, religious, political, or community leaders) that are credible to different audiences to share public health messages can be effective in increasing intentions to engage in recommended health behaviors. |
| 3. Leaders and the media might try to promote cooperative behavior by emphasizing that cooperating is the right thing to do and that other people are already cooperating. | Emphasizing cooperation and highlighting other people's cooperative behavior may encourage people to adhere to public health recommendations, though effects may be small. |
| 4. Norms of prosocial behavior are more effective when coupled with the expectation of social approval and modeled by in-group members who are central in social networks. | Surveys show that descriptive norms, especially when enacted by close reference groups, are associated with greater compliance with public health recommendations and self-reported prosocial behaviors. |
| 5. Leaders and members of the media should highlight bipartisan support for COVID-related measures, when they exist, as such endorsements in other contexts have reduced polarization and led to less-biased reasoning. | Where polarization regarding public health behaviors exist, endorsement from bipartisan coalitions may be effective in reducing polarization and increasing compliance. |
| 6. There is a need for more targeted public health information within marginalized communities and for partnerships between public health authorities and trusted organizations that are internal to these communities. | Marginalized communities have very different risks and health outcomes and may receive different information through different channels, suggesting the potential benefit for targeted communication and strategies. |
| 7. Messages that (i) emphasize benefits to the recipient, (ii) focus on protecting others, (iii) align with the recipient's moral values, (iv) appeal to social consensus or scientific norms and/or (v) highlight the prospect of social group approval tend to be persuasive. | Messages aligning with recipient moral values, appealing to social consensus or scientific norms, and highlighting group approval may be more effective, though field studies on messaging that emphasized recipient benefits or protecting others had minimal effect. |
| 8. Given the importance of slowing infections, it may be helpful to make people aware that they benefit from others' access to preventative measures. | There is compelling, albeit little, empirical evidence showing that it can help make people aware that they benefit from others' access to preventative measures. |
| 9. Preparing people for misinformation and ensuring they have accurate information and counterarguments against false information before they encounter conspiracy theories, fake news, or other forms of misinformation, can help inoculate them against false information. | Preparing people for misinformation before they encounter conspiracy theories, fake news, or other forms of misinformation - for example by ensuring that they have accurate information and counterarguments against false information, or by prompting them to consider accuracy - can help reduce belief in, and/or sharing of, false information for a limited time. |
| 10. Use of the term 'social distancing' might imply that one needs to cut off meaningful interactions. A preferable term is 'physical distancing', because it allows for the fact that social connection is possible even when people are physically separated. | While "physical distancing" is a more accurate term and may encourage social connection more, there is no evidence evaluating whether it is more effective in encouraging public health behaviors than compared to using the term "social distancing". |
| 11. As negative emotions increase, people may rely on negative information about COVID-19 more than other information to make decisions. In the case of strong emotional reactions, people may also ignore important numeric information such as probabilities and a problem's scope. | An increase in negative emotions related to the pandemic may influence behavior and decision making and lead people to ignore important information, such as probabilities of negative outcomes or actual risk level. |
| 12. Cultures accustomed to prioritizing freedom over security may also have more difficulty coordinating in the face of a pandemic. | Strong correlational evidence indicates that cultures accustomed to prioritizing freedom over security may also have more difficulty coordinating in the face of a pandemic. |
| 13. Fake news, conspiracy theories, and misinformation will have a negative impact on vaccine hesitancy. | Evidence shows that fake news, conspiracy theories, and misinformation negatively impacted vaccination intentions. Yet, the effect on actual vaccination behavior has not been shown. |
| 14. Unmitigated political polarization will disrupt or create other negative effects on attempts to minimize or end the pandemic. | Evidence shows that different partisan identities lead to significantly different opinions and reported behaviors in response to the pandemic, undermining coordination efforts to minimize or end the pandemic. |
| 15. Active use of online connections can reduce some negative mental and other health effects created by isolation policies. (Note: Examples of the harm created by passive use of social media may actually count as supportive evidence of this statement) | Active social connections online can buffer against negative mental health effects, although effects may be small. |

**Assessment of evidence for the 19 claims about behavior during the COVID-19 pandemic**

Following the procedure outlined earlier, over 500 articles were eventually assessed by at least four reviewers each (an exact number is not possible because many articles were assessed by some as not being relevant after being read by some, but not all, of the relevant reviewers). Of the 19 claims, 18 had at least some empirical evidence to assess, with only the claim that using "physical distancing" rather than "social distancing" might be more effective lacking any empirical research. Of the 18, 16 were generally supported in the direction of the original statement, with only two claims about messaging being widely studied in consequential settings but not indicating any meaningful effect. Of the 16 claims that were supported by the review, 11 were considered to show small effects, four were considered medium, and one large. The full assessment result is depicted in Table 2; all behaviors identified, whether or not specific to a claim, are listed in Table 3, which we include as a reference in the future for considering behaviors to expect or target. Importantly, no effects were in the opposite prediction from the original predictions.

Those 19 statements proposed behavioral domains that were likely to be of interest during the COVID-19 pandemic. Some claims were general about potentially relevant behaviors while others were more prescriptive about potentially more effective intervention approaches. Eight of the claims were assessed as having evidence from real-world, consequential settings, with one reaching the highest level of evidence and four being replicated in applied contexts. Ten claims were assessed as having been studied empirically, though only in survey or controlled laboratory settings.

Our review indicates that the Van Bavel article indicated considerable predictive validity consistent with subsequent research findings, of relevant behaviors during the pandemic (both positive and negative), of likely barriers to mitigating spread of the disease, and of major social challenges that would be faced by policymakers. The following text summarizes these in general groups, citing articles viewed by assessing teams as being most consequential for their final assessments.

**Table 2. Evidence assessments for 19 claims on social and behavioral science during the pandemic.**

| Claim | Evidence | Rating |
|---|---|---|
| 12. **Cultures** accustomed to prioritizing **freedom over security** may also have more difficulty coordinating in the face of a pandemic. | Evidence in support of this claim for correlations in different contexts and on different levels. Studies differ in the cultural dimensions assessed, including freedom/security, tightness/looseness, collectivism/individualism. | ★★★★★ |
| 2. Identifying **trusted sources** (for example, local, religious, or community leaders) that are credible to different audiences to share public health messages can be effective. | General support for the claim with a medium effect size from survey data in different samples and some applications in the real-world. The core claim is generally supported by the evidence. | ★★★★ |
| 7 I. **Messages** that (i) emphasize **benefits to the recipient** tend to be persuasive. | Although some online experiments find limited support for the claim, the general picture is mixed. Applications in the real world do not provide general support for the claim. | ★★★★ (grey) |
| 9.. Preparing people for **misinformation** and ensuring they have accurate information and counterarguments against false information before they encounter conspiracy theories, fake news, or other forms of misinformation, can help inoculate them against false information. | Robust positive effects seen in online experiments and real-world applications, although effect sizes vary. Meta-analytic assessments of the effectiveness of the interventions exist. | ★★★★ |
| 14. Unmitigated **political polarization** will disrupt or create other negative effects on attempts to minimize or end the pandemic. | Robust findings for effects of polarization in survey studies, but very few studies including manipulation or intervention. Context is very focused on the US. | ★★★★ |
| 7 II. **Messages** that (ii) **focus on protecting others** tend to be persuasive. | Some real-world studies are available for the claim and point towards no effect. Evidence from online experiments is mixed, although some studies find small positive effects. | ★★★ (grey) |
| 7 IV. **Messages** that (iv) **appeal to social consensus** or scientific norms tend to be persuasive. | Online experiments and survey studies find small positive effects of the suggested approach. However, field studies have inconsistent results. | ★★★ |
| 15. Active use of **online connections** can reduce some negative mental and other health effects created by isolation policies. | Existing studies point towards small positive effects, including one longitudinal study finding small to moderate effects in the real-world, but the number of studies is limited. | ★★★ |
| 1. A **shared sense of identity** or purpose can be encouraged by addressing the public in collective terms and by urging 'us' to act for the common good. | Some evidence to support the claim from survey data on online experiments, but no real-world assessments with observable outcomes. | ★★ |
| 3. Leaders and the media might try to promote cooperative behavior by **emphasizing that cooperating** is the right thing to do and that other people are already cooperating. | Some reported correlations support the claim, but the few experimental studies report small and inconsistent effects across contexts and outcomes. | ★★ |
| 4. **Norms of prosocial behavior** are more effective when coupled with the expectation of social approval and modeled by in-group members who are central in social networks. | Evidence generally supports the claim with a medium to large positive effect. However, the available studies assess the general effect of norms, not the specific context stated in the claim. | ★★ |

| | | |
|---|---|---|
| 5. Leaders and members of the media should highlight **bipartisan support** for COVID-related measures, when they exist, as such endorsements in other contexts have reduced polarization and led to less-biased reasoning. | Few papers despite widespread discussion of polarization. Highest quality paper supports claim and evidence largely validates that partisan policies disrupt impact, and greater bipartisan effort resulted in more agreement. | ★★ |
| 6. There is a need for more targeted public health information within **marginalized communities** and for partnerships between public health authorities and trusted organizations that are internal to these communities. | Empirical evidence for the core premise underlying claim exists, but little evidence is available that tests the effectiveness of the suggested approach. Existing studies suggest a small positive effect of targeted messaging. | ★★ |
| 7 III. **Messages** that (iii) **align with the recipient's moral values** tend to be persuasive. | No real-world studies with behavioral measures exist, but the evidence from survey data and online experiments mostly speaks for a small positive effect. | ★★ |
| 7 V. **Messages** that (v) highlight the prospect of **social group approval** tend to be persuasive. | Few studies tested this claim. The online experiments that do exist suggest small positive effects. | ★★ |
| 8. Given the importance of slowing infections, it may be helpful to make people aware that they benefit from **others' access to preventative measures.** | Widely supported by evidence available, though best evidence tended to focus on intentions rather than true behaviors. | ★★ |
| 11. As **negative emotions** increase, people may rely on negative information about COVID-19 more than other information to make decisions. In the case of strong emotional reactions, people may also ignore important numeric information such as probabilities and a problem's scope. | No empirical evidence that tested the full claim. Existing evidence focused more on the second part of the claim and pointed towards a small effect. | ★★ |
| 13. **Fake news, conspiracy theories, and misinformation** will have a negative impact on vaccine hesitancy. | Evidence from survey data and correlations were consistent with small to medium effect sizes. | ★ ★ |
| 10. Use of the **term 'social distancing'** might imply that one needs to cut off meaningful interactions. A preferable term is 'physical distancing', because it allows for the fact that social connection is possible even when people are physically separated. | Besides few small survey studies, support for the claim is largely conceptual, providing no evidence about potential effect sizes. | ★ |

*Color of stars indicate direction of effect (green positive; grey null). Size of stars indicate effect size (small, medium large).*

*Sense of identity (Claims 1-4-8-15)*

Four claims from 2020 focused on how social identities would be highly relevant during the pandemic, particularly how they aligned with either community benefits or social norms. These expectations generally appeared to be accurate, with scores of studies concluding that connectedness with communities or aligning with morals were a predictor of behaviors and controlling the spread of illness[52,64–78]. However, one challenge that is typically present for research on subjective and latent constructs such as identity, prosociality, and connectedness is that most research was conducted through surveys. Few studies attempted to isolate the causal effect of identity on pandemic behaviors, and no experimental studies manipulated identity or the sense of collective purpose in a real-world setting. In some cases, well-powered studies directly assessing the claims were limited to asking about intentions to receive vaccines[78]. While such findings are very valuable, there is clearly additional benefit in validating those findings in consequential settings, or even carrying out retrospective studies to determine whether behaviors or infections were measurably associated with connectedness where studies were conducted.

*Trust & leadership (Claims 2-3)*

There was a large amount of evidence from peer-reviewed research or mainstream media on the role of leadership during the pandemic. Two claims from 2020 specifically outlined expectations for how trusted sources and leadership may be relevant to promoting public health guidelines. There was a significant amount of research supporting these expectations, though the best quality evidence from consequential settings was replicated only in relation to the claim that the most effective messaging comes from trusted sources[79–84]. Similar conclusions were made for how leaders could promote cooperation, but this evidence was limited to surveys and correlational studies.

*Messaging & language (Claims 5-6-10-11 and all components of Claim 7)*

Perhaps the most widely-studied topic during the pandemic was public health messaging. This was clearly anticipated by Van Bavel et al. as nine of the 19 claims explicitly discussed the role of messaging and language in developing effective public health interventions. Not surprisingly, this also produced the most heterogeneous set of evidence ratings. Some aspects were popular in the mass media, such as whether "social distancing" should be replaced with "physical distancing", but yielded essentially no meaningful evidence for policy. On the other extreme, observational studies carried out in natural settings concluded that messages that directly emphasized benefits to individuals or for protecting others had no measurable effect on behaviors[51]. In contrast, studies on behavioral intentions often did show an impact, though some studies suggested that self- versus other-benefit messages were differentially effective for different types of people. Research on translating intentions into concrete actions is needed.

Messaging as it related to partisan concerns was also widely studied, though not often in consequential settings. For the studies with the most policy-relevant evidence, it was generally clear that messages emphasizing consensus and general agreement about public health behaviors were more effective in promoting these behaviors than those considered to be polarizing or partisan in nature (in survey studies)[49]. A small number of related studies in the context of marginalized communities converge on the idea that more engagement and direct messaging is more effective[85].

*Misinformation, polarization, social cohesion (Claims 9-12-13-14)*

Claims specifically related to polarization and flawed sources of information were widely validated with some caveats[86]. Although direct causal evidence was relatively scarce[87], across more than 200 published

article conclusions consistently converged on the idea that polarizing and disingenuous[88] messaging were associated with negative outcomes in terms of the effectiveness of public health interventions. Studies with the highest levels of evidence validated these patterns in consequential settings, often with medium effect sizes, largely indicating that greater division in messaging and lack of social cohesion were associated with lower effectiveness of public health messaging[66,87,89–100]. Encouragingly, inoculating against manipulation techniques[101] and prompting users to consider accuracy before sharing news[102] have shown some positive effects. Again though, both lines of study would benefit from replications in consequential settings, with some additional validating work on this emerging after the review started[103].

**Table 3. Behaviors directly studied in articles from initial literature review**

| | |
|---|---|
| Washing hands | Going to hospitals |
| Standing 6ft/2m apart | Postponing treatment |
| Staying at home | Spending stimulus money |
| Reducing visits to store | Attending school remotely |
| Wearing a mask | Attending school in-person |
| Wearing a correct mask | Following/ignoring guidelines |
| Wearing a mask correctly | Volunteering |
| Wearing a best-fitting mask | Promoting cooperation |
| Avoiding crowds | Promoting division |
| Using public transportation | Messaging on social media |
| Exercising at home | Using dating apps |
| Exercising outdoors | Moving home with family |
| Dieting during isolation | Isolating within home |
| Consumption during isolation | Joining military during COVID |
| Using the internet | Recycling & plastic consumption during COVID |
| Using social media | Death* and suicide |
| Sharing public health info | Downloading/using tracking apps |
| Sharing misinformation | |
| Getting tested | *Trust* |
| Testing at home | *Prosociality* |
| Visiting nursing homes/elderly | *Intentions* |
| Getting vaccinated for COVID | *Beliefs* |
| Refusing COVID vaccination | *Preferences* |
| Delaying COVID vaccination | *Polarization* |
| Getting 2nd shot (of 2 doses) | |
| Getting COVID booster | *Death was a heavily-studied outcome that was |
| Getting flu shots | linked to both the coronavirus as well as to |
| | behaviors. There was debate as to whether it |
| Choosing single-shot doses | should alone count as a behavior, so we include |
| Using fake vaccine cards | it for readers to decide. |
| Using unsupported treatment | |
| Working remotely | *Italicized terms were behavior-adjacent latent constructs that were commonly measured but are not possible to assess with simple binary, objective measures* |
| Using mental health services | |

**Major themes not explicitly assessed**

Although the Van Bavel et al. article addressed a broad range of behaviors and topics of interest to behavioral scientists, several themes emerged during the search phase of this project that were discussed by the original authors, but not necessarily formalized in terms of a specific claim. These included discussions of the extensive relevance of threat and risk perception, the role of inequality[104] and racism[105], skepticism toward science[106], incentivizing behaviors beyond simply describing benefits (such as financial rewards for vaccination)[107–109], and the absence of clear leadership[110–115].

*Threat perception*

While ignoring threats and risk were concerns raised in the 2020 article, the statement assessed as a claim (11) did not yield a substantial amount of evidence to review. However, this was not because there was an absence of evidence relating to this issue. In fact, substantial research indicated that threat perception - and willful decisions to ignore risks to self and others - were a major factor during the pandemic[116–118]. However, we chose not to create an additional generic claim to assess evidence related to this not only to maintain consistency in the method but because much of the research on this topic is heavily associated with the polarization, messaging, and misinformation themes. However, there is clear and compelling evidence that deliberate decisions to ignore health information had negative impacts during the pandemic[116,117].

*Nudging*

Nudging was a widely attempted method for behavioral interventions during the pandemic. Huge increases in attempted nudges have arisen since late 2019, largely due to the highly behavioral nature of pandemic policies. Though not explicitly framed as a claim in the 2020 article, nudging was highlighted as a practice likely to have a significant bearing on pandemic-related behavior.

Overall, interventions presented as nudges had mixed effectiveness during the pandemic. Encouraging evidence found that simplifying choice architecture and making options salient (e.g., through personalized text messages) as well as making it easy to become vaccinated led to reductions in vaccine hesitancy[50,119]. The same was found for improving availability of locations to receive a vaccine[116]. Accuracy prompts also showed promise as nudges that aimed to limit sharing of misinformation[102,120], though replications have found generally small effect sizes for these nudges[102,121]. However, attempts at making use of lotteries to increase vaccination rates showed no overall effect[107], along with studies reviewed in Claim 7 on messaging, which also showed little impact[51].

Because of the extreme number of trials, there is no single summary assessment that would appropriately cover the highs and lows, or complexity, of nudging during the pandemic. Several systematic reviews[122,123] have explored the overall effectiveness of nudges, and more narrow ones have considered the effectiveness of nudges that target specific behaviors, such as vaccination[119]. In light of this mixed picture, we strongly encourage focused systematic reviews of all nudging carried out in the context of COVID-19.

*Stress and coping*

Unfortunately, the fear that isolation and lack of social connectedness would lead to a pandemic of mental illness largely played out.[124–126]. While much of daily life around the world adapted to major changes, the risk of prolonged and severe impacts on mental health were widely identified, with large increases in depression, anxiety, stress, and other common mental disorders reported globally[127]. In some cases, these effects were moderated (or at least attenuated) by being isolated along with close

others[128], while other studies showed dramatic increases in intimate partner violence and violence against women[129,130]. Though not able to circumvent all aspects, in line with the 2020 article, some positive mental health outcomes had direct links to mindset and perspective[131]. Those patterns indicated a need to take more multi-dimensional approaches to well-being and mental health to find opportunities not only to treat or prevent illness, but to promote positive outcomes[132].

*Major behavioral themes during the pandemic*

While matters such as polarization and vaccine hesitancy were discussed in the 2020 article and turned out to be clearly relevant, other themes not specified originally were widely studied. For example, political divisions were not the only reasons individuals refused or delayed vaccination[133,134] as there was also evidence of general willful refusal to follow public health guidelines (whether masking, social distancing, isolating when sick, avoiding unnecessary travel, vaccine hesitancy, and so on) in some quarters[135]. In this regard, explicit, manifest behaviors based on demographics and individual differences[136] should also be reviewed as they have not been covered here. Those patterns are not inconsistent with perceptions, beliefs, and social division, but we have not explicitly assessed that evidence. While some evidence pointed to the benefits of communicating good and effective policies directly to the public[137], more needs to be done to explore how to achieve this when there is active, deliberate intent to criticize and disrupt those policies, without inadvertently giving greater visibility to those disruptive forces.

Other major themes not covered in Van Bavel et al. include more specific predictions about what outcomes may be associated with behaviors or interventions. For example, while there was some mention of isolation impacting mental health, volumes of research looked at how school closures[138] and curfews[139] might impact children by limiting opportunities for interaction, playing, and development, weighed against their likely effect on mitigating the spread of illness. Similarly, beyond social media, ways to address isolation might have involved better ways to engage communities in volunteering[140] or other civic contributions for those that desired a more active role during periods of extended isolation.

Another theme not discussed was how traditional forms of mass media might have undermined the potentially helpful role of descriptive norms by giving disproportionate attention to anti-vaccination, conspiracy and other beliefs that did not reflect expert or even majority opinion in the general public[71,141]. Many countries, particularly those covered in the original article and where evidence was available for this review, had vaccination rates above 70% (and sometimes above 90%). In these settings, messaging that focuses on the problem of vaccine refusal could mean giving a minority behavior the same amount of attention as facts and evidence about widespread uptake and the benefits of vaccination[83]. In this regard, efforts of academics and public health officials may be thwarted if media policies around"'equal coverage" are implemented in ways that amplify false norms and harmful, fringe ideas, given how easily it is to manipulate or control narratives that are not rooted in evidence.

**Error**

One critique of the original article was that the evidence applied by authors was not necessarily field-tested in a way that would justify policy implementations during an emergency. The argument essentially noted a form of Type 1 policy translation error in which social and behavioral scientists recommend an intervention that does not work (false positive). However, the reverse of this critique is also a risk potentially more harmful: should there be no attempts to use effective messaging techniques during a public health emergency? It also reflects a lack of understanding of policy, resulting in a Type 2 policy translation error in which interventions might have been successful but were not used (false

negative). Most policies cannot be perfectly informed by evidence, because many public challenges are only known when they emerge and require actions followed by evaluations.

We also note that our assessment of evidence is an amalgamation of a substantial number of indirectly related studies, which each include their own potential forms of statistical and researcher error. By taking the approach described above, we aimed to minimize the multiplication of error by encouraging all reviewers to factor in the quality of studies to avoid conflating good evidence with unreliable findings and thereby hopefully limit the likelihood of Type 1 error. This resulted in widespread agreement about the direction of findings for most claims. Moreover, this direction was predominantly positive (i.e., supportive of those claims).

Where there was less agreement, however, was in the size of effects. This increases the likelihood of Type M[142] error in the consolidated assessment: the true magnitude of the patterns and effects may be different from those we report. Thus, Table 2 values should be considered indicative rather than absolute. The original plan for this evaluation was to split values based on whether reviewers were original authors or in the independent team, but as there was no clear pattern of difference between these two groups of raters, suggesting a broad consensus between the original authors and the new set of independent set of reviewers. Thus, a single value has been presented.

The more consequential distinction in assessments pertained to the classification of "real-world evidence." This was a persistent challenge in assessing evidence because no clear rule is universally applicable for what counts as "consequential" or "real-world." In some cases, reviewers were suggested (but not required) to use this general guideline: 'a survey that asks individuals if they intend to get vaccinated is not real-world; clinical data on the number of individuals getting a vaccine is.' However, this instruction has two major limitations. The first is that there is a grey area between those classifications: if an individual reports getting vaccinated, should this be treated as real-world? The second is that more subjective and latent constructs such as mental health are almost canonically assessed via surveys. For example, an online survey of mental health and social media use may not be as objective as clinical admission for depression and a monitor on a phone that tracks social media use. However, the core material may not vary substantially in those instances. In this way, Type M error is also a concern, but it is one that policymakers and practitioners can appraise themselves in relation to their goals in a given context even if reasonable minds may disagree.

While the focus of this review was evaluating evidence based on 19 claims, additional insights of relevance to science and policy were evident during the process. Here we provide a set of recommendations based on those insights.

*General recommendations for researchers*

1. **Think inside-out as well as outside-in.** Specifically related to the Van Bavel et al article, many of the insights presented perspectives on behavior from psychological scientists. This is understandable given the author list. As a result, matters of beliefs, perceptions, identity, individual differences, and other latent constructs were largely the focus of consideration. But while these were extremely valuable as core constructs shaping behavior, recommendations might also have been generated from the reverse perspective, starting with manifest concepts (i.e., from the behavior). For example, a review might have addressed the following questions: If they become available, how will people access vaccinations to stop the spread of the virus? How many individuals are likely to refuse vaccines? How long will individuals be willing to tolerate isolation? How can people stay active while remaining at home?

2. **Formulate testable claims**. Scientific guidelines can prompt researchers to develop highly precise or prescriptive statements. These do not directly map on to behavioral occurrences that can be observed or connect to potentially validating evidence of actual events. This was also a major challenge in preparing this review, resulting in many partially-relevant studies providing insight but not necessarily direct validation. For example, when determining if active social media use was positive for mental health, some studies showed that passive social media use was bad for mental health. That aligns with the claim, but does not directly validate it. Statements that are worded more deliberately or parsed into components (similar to Claim 7) increase the likelihood that studies directly test claims that are made. Doing this would also make it more feasible to produce systematic reviews of claims that can convince practitioners to take this evidence into account when developing policies or solutions.

3. **Test your assertions.** While many authors of the original 2020 article went on to conduct research in line with the claims they had made, many articles from 2020 (not just Van Bavel et al) had strongly stated predictions that were never subsequently tested. By this point in the pandemic, it is concerning to not have any clear validation or rejection directly from those recommending potentially influential policy interventions. At the same time, it is equally unfortunate that practitioners influenced by these recommendations do not systematically monitor whether the resulting policies actually have the intended effects. So, to steal a line from basketball: follow your shot!

4. **Beware of studying emergencies in terms of your research interests.** There is of course great value to research that does not speak to imminent policy needs. Particularly in the early stages of the pandemic, however, there were examples of papers that simply took existing research frames and attempted to impose these on the crisis, even when they were not particularly applicable. These covered many research interests, so we will not single any out as examples.

5. **Research what matters, not simply what you can easily study.** Much like the streetlight effect — in which people search for things where they can search most easily rather than where the things they need to discover are most likely to be found — sometimes the research that was conducted during the pandemic centered on what (or who) was easy to study rather than what needed to be studied. Accordingly, as much as it was important to confirm the claims that Van Bavel et al made, it is important too to know that they were *relevant*. But a challenge here is that knowing what needs to be known is not always easy. In particular, at the start of the

pandemic, there was little certainty about fundamental concerns such as how long people would need to be in lockdowns, whether and when vaccines would become available, and what behaviors might need to be encouraged or changed. Nevertheless, our sense from the present review is that most of the topics that were flagged in the Van Bavel et al. review did prove to have relevance to the unfolding behavioral dynamics of the pandemic. However, going forward, it would be good to develop methods for formally assessing this — to be sure that we have not staved off a replication crisis only to replace it with a relevance crisis.

6. **Amplify according to evidence.** Interventions that received widespread attention in public discourse and on social media were not necessarily those that were backed up with the most evidence (e.g., vaccine lotteries). Similarly, causal claims mistakenly or inadvertently based on observational data might mislead the public into assuming a direct causal link between, for example, individual differences and some preventive behaviors[136]. Researchers can be an important voice in focusing attention and resources where the evidence and potential impact are greatest.

7. **Consider the larger context**. Research findings may support very different effects in different settings.  For example, appealing to national identity in liberal democracies might have a very different effect than in authoritarian regimes. It is critical to acknowledge and reflect on ethical as well as empirical limitations. Settings within countries may also vary considerably.

8. **Study non-WEIRD populations.** Recommendations made using WEIRD samples should not be generalized uncritically. For instance, the socio and macroeconomic context in developing countries (e.g., the difficulty of sustaining a lockdown) demand specific strategies that may differ from the ones implemented in developed countries.

9. **Do not dismiss the value of null results.** In a context in which researchers all over the world are examining the same phenomenon, more balanced attention should be given to effective, ineffective, and harmful intervention results, and then the synthesis of those findings should also be made more visible. This will contribute to the faster advancement of scientific knowledge toward effective policies and reduce the risk of harmful or wasteful ones.

10. **Precision, error, uncertainty, and reality checks are always important.** Mathematical models from public health agencies were relied on heavily throughout the pandemic. However, these are limited without accounting for true human behavior. Behavioral scientists, particularly those working closely with public health agencies, can help address this gap by identifying how deviations from expectations may be based on sub-optimal choice patterns, noise, imprecision in variables used in the models, and barriers faced by the public.

<mark>**[END OF BOX 1]**</mark>

**Move beyond online surveys**

Behavioral scientists often utilize online, lab, paper-based, or other data collection tools with substantial environmental control. During the pandemic, considerable amounts of foundational evidence was produced this way. It is a privilege to have access to such high-quality research tools (or even to freely available versions) capable of facilitating meaningful research, and we do not discount how great a role those tools played. On the contrary, we find it encouraging that so much foundational evidence was produced so rapidly during the pandemic and note that not all research must have an immediate application to be valuable. Additionally, researchers often used online survey experiments because they offer insight on causality that, for example, descriptive or correlational field studies lack. Moreover, it is particularly encouraging that so much of that evidence converged, which further made clear the added value of having access to those resources.

There may, however, be opportunities to progress faster from concept-testing to real-world testing and implementation in future crises. In the earliest days of the pandemic, there was no clear way to do this, and large numbers of studies were derailed, postponed, abandoned, or forced to be modified substantially. Indeed, it is commendable how much social science was still conducted despite the chaotic circumstances, loss of resources, and universal uncertainty at the time. Nevertheless, of the approximately 400 studies given a ratings assessment as part of the present exercise, approximately 300 were empirical studies that were not conducted in consequential settings (noting that precise numbers are not possible here given differences in ratings between reviewers). Unfortunately, this also meant that many claims were only ever tested in narrow settings and as was evident in the reviews, often in redundant ways. So rather than this being a criticism, we state this as a strong encouragement to seek, promote, and fund partnerships that can function in consequential settings even (and perhaps especially) in the face of public emergency.

*Forge alliances*

Of course, it is typically difficult to bridge the gap from lab to practice. Institutions often find themselves short on resources and workers to engage experts. Many academics and other researchers were attempting to engage with policymakers during the pandemic, without question.

However, we encourage academics that have not previously worked in such consequential environments to reach out and contact potential partners, such as local government offices[143], hospitals[144], banks[145], schools[146] a local military unit providing emergency personnel[147], or others. Engage with organizations delivering public services to find out where and what input they would value[148]. Studies on "willingness to ___" or other self-report measurement are helpful, especially for developing a base of evidence that would justify intervention in the field. But it is important to remember that they are not a replacement for studying real behaviors like blood donations, vaccines, assigning volunteers, facilitating remote work, keeping people safe while shopping or voting - in the field.

For policymakers, managers, teachers, and other institutional leaders, we also strongly recommend opening lines of communications with academics that research your professional area. Professionals seeking to apply insights generated can experience frustration at the reluctance of researchers to offer practical advice for evidence-based policies. Academics are typically not trained in how to bridge the science-practice-policy gaps, and there are opportunities for impact in the future that may be in place if institutions also take the initiative to engage experts prior to emergencies. This is also a message for funding bodies: fund research initiatives and innovations that support joined-up thinking and hard-to-do translational research activity.

Both parties may feel reluctant and uncomfortable about such a collaborative effort, making them hesitant to consider working together as a viable option. Adopting a broader set of tools and research contexts would help both sides see how they can collaborate more productively by expanding and applying their knowledge of important psychological phenomena and behavioral mechanisms in practice.

**General discussion**

We approached this review with appreciation for how decisions had to be made throughout the pandemic, especially early on, without perfect evidence available. Our assessment focused on the quality, generalizability, and policy relevance of available data rather than the average effect size of research related to the claims, by performing an expert-driven assessment of claims rather than a formal statistical meta-analysis. We recognize that sometimes, even when strong evidence existed but external factors unrelated to evidence influenced decisions (e.g., political concerns, uncertainty about when a vaccine would become available). We also aimed to establish a standard for transparency and rigor in how such evaluations are approached. Recognizing these these challenges, we present general points on the development and assessment of evidence during the COVID-19 pandemic, as well as relevant limitations.

*Notes on rating evidence*

As this is the largest application to date of the THEARI framework for assessing evidence, there are naturally some recommendations for its future uses. The two most critical involve a slight shift in the scoring classification and having strict but useful definitions of what constitutes the "real-world." In the former, it may be better to adjust the evidence rating classification slightly by treating 'theory only' papers as 0 out of 5, and splitting empirical research conducted in controlled or survey settings into two categories. This is recommended as it was largely felt that advances in scientific standards in behavioral sciences in recent years have made it clearer which studies are more appropriate for consideration in public policy, or at least have greater overall quality in terms of reliability, robustness, power, and replicability. Accordingly, 'low empirical' evidence could be treated as a 1, with more robust, higher-powered (but still not consequential) evidence treated as 2.

The second recommendation speaks to a constant challenge of this study, as discussed earlier. There may not be a universal rule for establishing a threshold of controlled versus real-world evidence. As a result, evaluations for policy may need to introduce a rubric a priori, but allow some flexibility for debatable examples. There may also be value in doing reliability assessments of any classification that involve researchers, practitioners, and policymakers.

Finally, the rating system at present does not value evidence of causality more highly than correlational evidence. Thus, for example, a causal claim could achieve the highest rating level even without any evidence that the hypothesized relationship is in fact causal, only broadly replicated field evidence of correlation is needed. Where applicable, future work on the rating system could integrate the strength of evidence for causality, perhaps as an additional dimension.

*General limitations*

This evidence assessment was a major undertaking by over 70 researchers working in more than 30 countries. While not the first evaluation of its type, the complexity of tasks matched with the sprawling nature of pandemic impacts on behavior (and vice versa) meant that a number of challenging decisions had to be made at each phase of the research process. For posterity, we highlight the key limitations

created by those challenges here, some of which are universally true when it comes to evaluating evidence in relation to policy.

The primary table includes multiple aspects of the evidence review, including the ratings, direction, effect sizes, and a summary note. These were each included given that no single value can fully reflect the many dimensions of each behavioral domain considered relevant during the pandemic. We do not intend or claim to offer a perfect 'score' of evidence or research during the pandemic. Instead, our goal was focused on providing a general assessment of evidence that would be indicative for future research and policy applications.

Though some policymakers were asked to participate in the review, our focus was largely on leveraging academic expertise to inform policy. We therefore note that, at the highest level, evaluations may prioritize scientific perspectives over the insights most relevant to decision-makers and practitioners.

A final limitation is that the studies reviewed were only those published prior to June 1, 2022. More evidence will accumulate in years to come as people continue to understand and learn from the pandemic. Similarly, many public agencies may still be assessing their own interventions and have therefore not released reports due to vetting and dissemination processes. A focused follow-up on government programs is strongly recommended.

*What counts as evidence?*

There is no perfect metric to assess evidence for application. Even with considerable structure and standards aiming for objectivity, the process is fundamentally subjective. For example, consider a 2% increase in the number of people getting vaccinated following an intervention built on community-specific trust. Irrespective of statistical significance, some may see this as too small an effect to be meaningful for future attempts, especially if it came at a large cost to taxpayers. Others, particularly those that consider the indirect benefits and potential for other applications, or even simply that any potential for a saved life is sufficient, may see it as wildly successful. Furthermore, it is not only the content of the material that will be important, but the source. What may appear to some as a high-impact study may be considered questionable if it is published in, for example, a predatory or pay-to-play journal. However, it is not only predatory journals that publish questionable papers: as was observed during the pandemic, even reputable journals can fall victim to junk science, as seen when two of the most highly regarded medical journals were forced to retract papers on hydroxychloroquine[149].

Similar challenges also arose when it came to defining "behavior" versus more general concepts, or latent constructs that were widely covered in research. For example, while getting vaccinated is clearly a manifest concept that could be measured in binary choice terms, vaccine intentions and trust in science are more challenging to quantify and validate, though proxies of latent constructs are possible. There is considerable value in conducting parallel research that produces a more systematic and empirically-driven threshold for establishing these classifications, and this is something we would encourage. Such work would be especially useful if it tested different guidelines for classification and assessed the reliability across a diverse set of expert reviewers.

*Limited evidence is not bad science*

One concern raised by reviewers during the evaluation phase was the substantial number of papers considered as empirical-only evidence (i.e., not tested in consequential settings). However, in our view, this should not actually be seen as a concern or even a limitation. Indeed, it is a rather encouraging sign that behavioral scientists were heavily committed to building an evidence base at conceptual, controlled, or non-consequential levels prior to rolling out potentially impactful interventions across

whole populations (even though it was implied this caution had not been presented, as discussed earlier, that argument seems largely possible to dismiss). As discussed, there is certainly a need to pivot away from online studies to working in settings with partners of all types, but having a strong base of empirical evidence is undoubtedly a good thing.

One relevant note on the method did stem from this pattern of studies. While many theoretical or simple empirical studies was alone not a negative indication, no accumulation of such papers could ever constitute fully validated evidence. Therefore, even with many converging findings from well-powered studies in controlled settings, claims were not assessed as "applied". Contrarily, for claims where a large number of real-world studies were attempted, having many papers assessed as 3s or 4s can equate to an overall assessment of 5 ("impact"). This differentiation is important: many standalone, consequential studies from different populations, countries, settings, and domains can indicate replicability and clarity on the globalizability of a behavioral construct[60].


## Conclusion

On a scale without recent comparison, academic contributions from social and behavioral scientists were extremely visible throughout the COVID-19 pandemic[30,31]. Despite some limitations and setbacks, this is generally a positive sign and it points to a knowledge base that could be better leveraged in future emergencies. In this review, we assessed hundreds of articles using the frame of 19 claims made by academics early in the COVID-19 pandemic. We find high potential value to incorporating behavioral science into policies throughout, and that the vast majority of the 19 claims were positively validated (to varying degrees) by the subsequent literature.

In carrying out this review, we recognized the value of revisiting all such claims (predictive, indicative, or otherwise) made early in the pandemic beyond the article used as a frame here, including those from this very journal[17,23,34,150]. This has the capacity not only to contribute to the sort of transparency that builds trust in science and public health, but also to directly inform relevant tools for the next crisis. Building from that perspective, authors of similar publications that made claims or predictions in 2020 have hopefully tested these by now, and therefore may want to partner with evaluation teams who share the goal of wanting to better inform responses to future pandemics, global health challenges, and other public emergencies.

Finally, our last recommendation for the next pandemic is vital, and is directed to both academics and policy institutions: work together. Do not wait until the next crisis to form partnerships. Behavioral scientists should find partners from organizations, clinics, schools, governments, media, or any institution where there may be mutually beneficial partnerships for building effective policies. The value of a robust evidence base is clear; it is imperative to marshal our collective energies and resources in the service of protecting and promoting the well-being of populations.

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