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Using Behavioural Science to Help Fight the Coronavirus: A Rapid, Narrative Review

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Abstract:
This rapid, narrative review summarizes useful evidence from behavioral science for fighting the COVID-19 outbreak. We undertook an extensive, multi-disciplinary literature search covering five issues: handwashing, face touching, self-isolation, public-spirited behavior, and responses to crisis communication. The search identified more than 100 relevant papers. We find effective behavioral interventions to increase handwashing, but not to reduce face touching. Social supports and behavioral plans can reduce the negative psychological effects of isolation, potentially reducing the disincentive to isolate. Public-spirited behavior is more likely with frequent communication of what is "best for all", strong group identity, and social disapproval of noncompliance. Effective crisis communication involves speed, honesty, credibility, empathy, and promoting useful individual actions. Risks are probably best communicated through numbers, with ranges to describe uncertainty – simply stating a maximum may bias public perception. The findings aim to be useful not only for government and public health authorities, but for organizations and communities.

Keywords: COVID-19, Behavioral science, Narrative review, Interventions, Public Policy

There is great uncertainty about the scale of the COVID-19 pandemic, but it is understood that beneficial individual and collective public behavior can reduce transmission of the virus and ultimately save lives (Anderson et al., 2020). Research in behavioral science has increased in both quantity and quality over recent decades, with leading researchers successfully communicating advances to policymakers and generalists (Thaler & Sunstein, 2008; Kahneman, 2012) and widespread application to policy problems by governments and international organizations around the world (Sunstein, 2011; OECD, 2017). Consequently, there is a body of applied scientific knowledge and evidence that can be called upon in the fight against COVID-19.

Our aim here is to distil the relevant evidence to inform those trying to fight the disease. The review is written to assist policy officials, administrators, practitioners and researchers to grasp the evidence base quickly. We identify areas where we can be confident of our knowledge. Yet we also highlight areas where the evidence is mixed or weaker, implying the need for a more cautious approach and for additional research and learning as the response to COVID-19 develops.

We address five behavioral topics: handwashing, face touching, self-isolation, public-spirited behavior, and responses to crisis communication. The first three were chosen because they form the basis of the public health messaging in multiple countries with respect to individual behavior. The second two were selected because they are key behavioral drivers of adherence to public health guidance during an epidemic. Given the nonlinear dynamics involved, adherence to guidance can reduce the rate of transmission, lowering both the

overall number of infections and the number of cases at the peak of the epidemic (Anderson et al., 2020; Haushofer & Metcalf, 2020), when health services will be most stretched. Each topic is addressed in a separate section, which describes available evidence and contains a final paragraph that draws conclusions. We summarize the findings in Table 1. The final section contextualizes the findings and considers issues that apply across the five topics.

This work has been produced more rapidly and at shorter notice than would be standard for research of this type. Consequently, our review is narrative and not systematic. However, the review was conducted by a team of applied behavioral scientists who specialize in generating evidence for policy in Ireland and for international organizations. The team used a large range of academic databases to accumulate the most relevant papers they could find for each of the topics (including PubMed, Scopus, PsychInfo, EconLit, ScienceDirect and Google Scholar). The initial strategy was to search for relevant review articles. References were also gathered on an ad hoc basis from group emails, tweets, and blogs from members of the international applied behavioral science community, which were posted as the epidemic began to unfold. These were mostly contributed by applied academics in universities, or by researchers working in national and international behavioral teams. We did not apply a date range, disciplinary filter, or journal publication criterion (some relevant working papers are included). Once papers were initially identified, others were located by upward and downward citation. More than 100 papers were reviewed in total. Evidence was weighed based on soundness of scientific method and relevance for policy and practice. For assessing interventions, we prioritized evidence from controlled trials.

Table 1.

Summary of Main Findings

Behavioural Topic	Finding	Evidence Base
Handwashing	Education and information are important but not sufficient to change habits. Attracting attention, making compliance easy, and messages that refer to disgust increase the use of alcohol-based hand sanitizer. Placing sanitizer centrally in prominent public spaces (e.g. entrance lobbies), with colourful signs, increases use.	The evidence for handwashing interventions is strong, with multiple methods used.
Face Touching	Interventions need to alter physical and social environments to change behavior.	We can find no evidence for interventions that reduce face touching, but principles from behavior change models may apply.
Entering and Coping with Isolation	Authorities should supply and promote additional supports and advice for people undergoing isolation. Engaging social networks remotely and maintaining a routine are likely to lessen negative effects of isolation on wellbeing.	The evidence for negative mental health effects of isolation is strong. The evidence for the effectiveness of preventative measures rests on a small number of studies.

Collective Action	Public-spirited behaviour is more likely when strategy that is "best for all" is clearly articulated and repeated. Stronger group identity - nationally, locally, within organizations - enhances collective action. Reasonable punishment of noncompliance, including social disapproval, is helpful.	The scientific literature on collective action is multidisciplinary and robust, providing strong evidence on the importance of these factors for increasing co-operation.
Crisis Communication	Authorities need to show empathy in communications and demonstrate that they understand how people feel. Campaigns are likely to be more effective when designed to be distinctive, consistent, engaging, and relevant. Social media messages that invoke intrinsic motivation to help others can be effective, but social media as a medium can be helpful or harmful.	Crisis communication studies are often highly specific, but useful principles emerge in aggregation.
	To avoid some known biases in risk perception, authorities and media can use numbers and ranges to communicate risks, stating that the middle of the range is most likely, for example "anything ranging from 3,000 to 22,000, but a figure in the region of 12,000 is most likely".	The evidence base for biases in risk perception is large and robust, but there is no "best practice" based on established evidence.

Handwashing

Behavior change interventions that target everyday activities must overcome a common and substantial barrier: habits. Habits are highly efficient, designed to free up our minds to concentrate on other matters (Gardner, Lally, & Wardle, 2012). By definition, habits operate mostly outside conscious awareness and are hard to break through improved education and knowledge. For instance, even in acute healthcare environments, attempts to improve hand hygiene and other infection control behaviors through education and awareness have limited and short-term impacts (Edwards et al., 2012).

There is, however, a body of work that provides robust evidence that some interventions are successful. A 2001 review of research in hospitals found that combining educational interventions with reminders and better facilities (e.g. automated sinks) can increase handwashing (Naikoba & Hayward, 2001). A 2012 follow-up concluded that multiple behavioral levers are required, including social influence, convenience, prompts, and cues (Huis et al., 2012). Later studies point to benefits from placing alcohol-based hand sanitizer (AHS) in highly visible locations (Gould et al., 2017). A crucial aspect of successful handwashing interventions is to capture attention. Placing an AHS stand in the middle (versus the side) of a hospital entrance lobby increased usage substantially (Hobbs et al., 2016). More visible, proximate, and convenient locations for AHS dispensers increases their use (Cure & Enk, 2015), more so than increasing the number of dispensers (Chan, Homa, & Kirkland, 2013). Another study increased use by deploying flashing lights to draw attention to the AHS (Rashidi et al., 2016).

Fewer interventions have been studied outside healthcare settings. A 2018 review of research in office workplaces found that simple provision of hand hygiene products, accompanied by education on how to use them, usually resulted in significant improvements in hand hygiene compliance (Zivich et al., 2018). Modest increases in soap use in public toilets can be obtained via written signs (Judah et al., 2009). Towel and soap dispensers that do not require user activation also help (Ford et al., 2014). Messages linked to disgust tend to be effective (Porzig-Drummond et al., 2009), while evidence does not support messages that communicate social norms ("4 out of 5 people wash their hands every time…") (Lapinski et al., 2013).

Thus, evidence from multiple studies, including controlled trials, points to useful conclusions. Education and information, while important, are not sufficient to change habits. The physical and social environment needs to grab attention, make the behavior convenient, and reinforce it as a social norm. While messages that refer to disgust tend to be more effective, the primary goal for interventions is to attract attention and make compliance convenient. Consequently, AHS is an important tool. We conclude that evidence supports a policy in which organizations of all types place colorful AHS stands directly in front of doors and centrally in public areas such as lobbies, lift areas, corridors, and canteens.

Face Touching

In contrast to handwashing, we can find no proper scientific studies that evaluate interventions designed to reduce the frequency with which people touch their face.

Observational studies suggest that people touch their mouth, nose or eyes perhaps 10-20 times per hour (Kwok, Gralton, & McLaws, 2015). When people are asked to self-record face touching, the incidence increases rather than decreases (Lipinski & Nelson, 1974), meaning that making people self-conscious may backfire.

The issue of face touching therefore raises the question of how to encourage a specific behavior in the absence of direct evidence. Behavioral scientists have developed guides, drawn up from research across domains. These include the "Behavior Change Wheel" (Michie, van Stralen & West, 2011), which centers on a model of behavior change consisting of three essential elements: capability, opportunity, and motivation. Individuals must be psychologically or physically able to undertake the behavior, the environment that surrounds them needs to facilitate the behavior, and their own mental processes need to energize and direct the behavior. The researchers behind this approach have advocated its use in the context of COVID-19 (Michie, 2020). The EAST framework (Behavioural Insights Team, 2014) emphasizes that behavior change is more likely when the behavior is made Easy, Attractive, Social, and Timely. What is common to these frameworks is recognition that education and information are not enough on their own; we need to alter physical and social environments as well as understanding and mindset.

With respect to face touching, a physical intervention might be to place tissues in prominent locations (e.g. immediately beyond the keyboard for office workers, on lunch and coffee tables), so that people can use them and not their hands to scratch an itch. A social intervention might be for the public health authorities to encourage a specific change in

social acceptability, perhaps encouraging scratching with the sleeve. The UK's Behavioural Insights Team has made similar suggestions (Hallsworth, 2020).

Entering and Coping with Isolation

Part of the necessary response to the COVID-19 outbreak is self-isolation by individuals with symptoms or who have been in close contact with infected persons. While self-isolation can help to contain and control the spread of infectious diseases (Day et al., 2006), isolation can have negative psychological effects. We found a substantial number of studies offering clear evidence of negative effects, but also a smaller number suggesting that awareness of these consequences may help people to prepare and, where possible, prevent them.

It is well-established in the psychology and public health literature that social isolation is detrimental for wellbeing, with effects comparable to other well-known risk factors such as smoking (Holt-Lunstad et al., 2015). Loneliness is associated with increased risk of mental health problems, including depression and anxiety (Cacioppo, Capitanio, & Cacioppo, 2014).

A recent review of 24 studies, in which individuals were quarantined for durations ranging from several days to several weeks, sheds light on possible consequences (Brooks et al., 2020). While distress and irritability from lack of social contact, loss of freedom, and boredom during quarantine might be expected, some studies indicate long-term effects, including depressive symptoms (Liu et al., 2012) and substance dependence (Wu et al., 2008) up to three years after quarantine ended. The review highlighted specific implications for healthcare workers, who can become concerned about failing to support co-workers during

the outbreak (Maunder et al., 2003), can be stigmatized following quarantine (Lee et al., 2005), and sometimes self-isolate beyond the quarantine period (Marjanovic, Greenglass, & Coffey, 2007).

The review also shows that duration of isolation is important. Longer periods are associated with poorer mental health outcomes (Hawryluck et al., 2004) and increased anger (Jeong et al., 2016). Extending the isolation period beyond initial suggestions can demoralize people and increase non-compliance (Rona et al., 2007). Thus, clarity and certainty about timelines are both important.

The mental health effects of loneliness during isolation can be exacerbated by loss of routine, which is linked to multiple negative mental health consequences (Lyall et al., 2018). Protective behaviors such as sleep (Irish et al., 2015) and exercise (Chekroud et al., 2018) can be disrupted and hindered during isolation. Children may be especially susceptible to such changes in routine (Wang et al., 2020).

Planning for the effects of social isolation can help individuals to cope (Sniehotta et al., 2005). Plans are easier to follow if they are time-specific and intentional, rather than general aspirations (Gollwitzer, 1999). Plans may be devised to engage with social networks remotely, via phone and video calls or social media (Shaw & Gant, 2004). Activating social networks may be particularly important for those living alone. People can maintain aspects of routine that remain possible during isolation, such as keeping alarms set to usual times, maintaining working hours, and planning home-based exercise (for those well enough)

(Michie, 2020). Creating plans in advance of isolation, discussing plans with others and incorporating familiar routines may help people to overcome anxiety. "Mere" exposure to choices is established to reduce uncertainty and promote positivity towards those choices (Lee, 2001). That is, greater familiarity with a course of action typically makes it more attractive.

A danger is that perceived negative consequences of isolation hinder voluntary engagement. When deciding whether to engage with proposed health solutions, people consider not only their susceptibility to the threat and its severity, but how effective they perceive the solution to be and the nature of the required behavior. For instance, some people actively avoid receiving important medical information when it might lead to an undesirable action, such as learning that they might need surgery (Sweeny et al., 2010). People express unwillingness to isolate themselves when they harbor doubts about the chances of infecting others, but report greater willingness when they consider the possible effect on the most vulnerable in society (Kappes et al., 2018). Thus, if people anticipate and fear negative consequences of self-isolation or fail to reflect on spreading the virus to those most at risk, they may downplay or not acknowledge symptoms of COVID-19 to avoid possible isolation.

Overall, evidence clearly indicates negative mental health consequences from isolation. The implication is that authorities need to supply and advertise additional mental health services, including support lines and advice, for people who undergo isolation. Although the evidence-base is less strong, helping people to create plans is likely to help. This includes encouraging people to inform their social networks that they are isolated and that they would

like messages and calls, as well as maintaining some routine. Familiarizing people with the process and ways to cope is likely to increase compliance.

Encouraging Collective Action

Each person's chance of contracting COVID-19 depends not only on their own behavior, but also on the behavior of their fellow citizens. Initial data show that young people face a substantially lower risk of succumbing to COVID-19 than older people (Sohrabi et al., 2020), yet willingness to adapt their behavior will, in turn, influence how many older people get the virus (Karan, 2020).

Similar problems, where individual and societal incentives do not align, have been studied under multiple labels ("public good games", "social dilemmas", "collective action problems", "common pool resource"). It was demonstrated some time ago that many, though not all, individuals will override self-interest and act in the collective interest (Ostrom, Walker, & Gardner, 1992; Ledyard, 1995). Perhaps a majority of the population are what are referred to as "conditional co-operators" (Chaudhuri, 2011), who are willing to make sacrifices for the public good provided that others are too, but cease co-operation if too many other people don't bother.

Large scientific literatures have established strong evidence bases for at least three conditions under which public-spirited behavior is more or less likely. The factors that stand out are communication, group identity, and punishment. Importantly, while these regularities were

initially demonstrated in laboratory experiments, they have since been verified in real-world applications (Fehr & Schurtenberger, 2018).

Co-operation is improved, often substantially, by communication (Zelmer, 2003). Clear statements of a desired collective behavior that is in the group interest, articulated by leaders and repeated by others, are beneficial. Such communication enhances trust, establishes social norms, and encourages individuals to commit to the behavior (Bornstein, 1992). Observation of effective communication when facing social dilemmas reveals that it is the articulation of how the behavior is "best for all", rather than persuasion to undertake the specific behavior, that most supports co-operation (Pavitt, 2018). This evidence, for instance, suggests that one of the most effective arguments to promote compliance with isolation is that self-isolation in response to symptoms is the best way for all of us to prevent infecting each other.

The more people feel part of a group or community response, the more likely they are to make a selfless contribution (Chaudhuri, 2011). This finding is particularly true of responses to threats, which generate a stronger public response when framed in group rather than individual terms (Carter et al., 2013).

Co-operation is more likely when individuals' contributions are publicly visible and there is punishment for those who do not pull their weight (Fehr & Gächter, 2000). This punishment need not be material, but can consist simply of polite social disapproval (Masclet

et al., 2003). Where punishment is itself unjust or antisocial, it can backfire (Herrmann, Thöni, & Gächter, 2008).

These evidence-based principles can be used to encourage people to engage in beneficial behaviors, including handwashing and self-isolation where necessary, but they are equally applicable to undesirable behavior, which might include panic responses, undue expressions of anger towards officials or health workers, xenophobic responses to people of a race or nationality perceived to be high-risk, or unsympathetic responses to those who contract the virus.

Encouragingly, studies suggest that mutual assistance is a more common response to a crisis than mass panic and social disorder (Mawson, 2005). The recent experience with swine flu (H1N1) is a case in point (Rubin, Potts, & Michie, 2010). Nevertheless, severe social and economic disturbances can occur in response to disease outbreak. Overreaction is not limited to the public, but can also affect professionals and workers in healthcare systems (Bonneux & Van Damme, 2006).

We can find surprisingly little high-quality evidence on the drivers of panic buying and or efforts to prevent it. Panic buying has been widely reported in the media in multiple countries and there is concern that it may affect supplies of vital medical equipment in low- and middle-income countries in particular (Hopman, Allegranzi, & Mehtar, 2020). Several studies have investigated responsible versus irresponsible media coverage in driving panic. An initial analysis of worldwide coverage of the coronavirus has raised concerns about

alarming language, such as "killer virus" (Wahl-Jorgensen, 2020). However, a recent review of research into swine flu coverage concluded that while there was some evidence of overdramatization, the bigger issue was the focus on reporting the threat (number of diagnoses, etc.) at the expense of communicating how best to fight the disease (Klemm & Hartmann, 2016).

An important concern is the possibility that specific social groups perceived to be associated with the virus might face discrimination or ostracization. For instance, Asian-Americans experienced discrimination during the SARS epidemic (Person et al., 2004). In general, people who feel more vulnerable to disease express more negative reactions to out-groups, and priming people to think about disease increases ethnocentrism (Navarrete & Fessler, 2006). Some allegations of anti-Chinese racism in response to the virus have already been made (e.g. Shimizu, 2020). To combat this, strong messages from leaders might stress both the social unacceptability of any xenophobic behavior and the importance of understanding that different people face the same threat and share a common goal (Böhm, Rusch, & Baron, 2018).

In summary, the fight against COVID-19 is collective, not only at the international or national level, but within localities, workplaces, and households. There are large and robust evidence bases that document systematic influences on willingness to make sacrifices to support better collective outcomes. Language and leadership matters. Strong communication of a common strategy to fight the disease is likely to increase adherence to prescribed behaviors. Stronger group identity, where behavior is about "we" and "us" rather than "I" or

"you", will make more public-spirited responses likely. Media reporting matters too. Faithfully reporting that people are trying to follow advice, assuming that they are, will be as important as highlighting failures to follow it, because conditional co-operators need to know that others are co-operating. Where behavior falls short, a reasonable degree of disapproval is helpful. Polite but clear interventions when public health advice is not followed are likely to improve behavior. For more serious undesirable behavior, clear leadership and statements about unacceptability are required, coupled with visible use of available punishments for people who transgress. We are in this together.

Crisis Communication

A scientific literature covers how people respond to crisis communication and aims to identify the best ways to communicate in a crisis. Although this literature contains many useful studies, they are typically specific to single countries or incidents. Nevertheless, useful principles emerge across studies. These may be helpful not only for national communication but across the public health system, to balance the need to inform and motivate against the danger of inciting unnecessary fear (Jin et al., 2019). This section also documents known biases in risk perception for which the evidence base is well-established.

The word "unnecessary" is important here, because fear is a legitimate force that can positively influence attitudes, intentions, and behaviors (Tannenbaum et al., 2015), especially when combined with communication about how to respond. There is an ongoing scientific debate about whether 'fear appeals' generate long-term behavior change. However, the

consensus is that they are more effective when perceptions of self-efficacy (belief that one's own actions make a difference) are high (Peters et al., 2018).

Messages can be designed to elicit emotions other than fear. Evidence shows that 'empathy appeals' can have positive impacts on behavior change (Shen, 2015). In the context of smoking, social marketing that portrays realistic narratives involving loss or pain within personal relationships can be as or more persuasive than graphic 'fear appeals'. Similar empathetic framing may strengthen belief that a community working together can do something to mitigate the effects of a crisis (Shen, 2010).

Different subgroups can respond differently to communication during a crisis, which may be important for more vulnerable groups (Vaughan & Tinker, 2009) but also helpful for good crisis communication. Making communication sensitive to the demographics of the intended recipient helps people to feel that society is more prepared (Heath, Lee, & Ni, 2009). For example, African American women were more likely to test for HIV after viewing a video featuring a presenter matching their gender, and more likely still when the context of the messages were framed in a culturally relevant way (Kalichman & Coley, 1995).
Marketing research finds that public health campaigns are more effective when they apply principles that are successfully used by private companies – be distinctive, consistent, engaging, and relevant (Romaniuk & Sharp, 2004; Danenberg, 2018). For example, catchy phrases or mnemonics help children and families retain important public health information. The Australian 'Slip, Slop, Slap' sun protection campaign is an example of the widespread,

lasting impact on behavior that campaigns which incorporate these principles can achieve (Montague, Borland, & Sinclair, 2001).

Social media has opened new avenues for communication (Toppenberg-Pejcic et al., 2019) and offers potential for rapid information dissemination (Kass-Hout & Alhinnawi, 2013). It can be harnessed to promote altruistic behavior. Messages that convey a moral imperative for people to act and messages that evoke strong emotional reactions are more likely to be shared, with those that invoke an internally sourced 'intrinsic' motivation to help others generally lasting longer than ones that leverage extrinsic incentives to do 'good' (Van Der Linden, 2015).

However, it has become clear that social media can also contribute to the spreading of inaccurate information (e.g. Bovet, & Makse, 2019), whether malign or merely misinformed. Indeed, evidence on the benefits of social media in crises is mixed. In relation to the Zika and Ebola viruses, studies have suggested that use of social media messaging by authorities may not be beneficial for knowledge (Abramson & Piltch-Loeb, 2016) and can increase focus on panic and uncertainty (Kilgo, Yoo, & Johnson, 2019). Following the 2015 MERS (Middle East Respiratory Syndrome) coronavirus outbreak in South Korea, those exposed to information on social media were more likely to experience fear and anger, although both emotions were positively associated with the extent of subsequent preventive behaviors (Oh, Lee, & Han, 2020).

The US federal agency, Centers for Disease Control and Prevention (CDC), has previously distilled evidence into six guiding principles for crisis communication (Reynolds, 2011). These are: (1) Be first: provide information as soon as possible or, if not possible, explain how you are working to get it and when. (2) Be right: tell people what you know when you know it, tell them what you don't know, and tell them if you will know later. (3) Be credible: tell the truth. (4) Express empathy: acknowledge what people are feeling. (5) Promote action: give people relevant things to do. (6) Show respect: involve stakeholders in decision making processes and try to meet media deadlines. These principles closely map onto those tested in a content analysis of US media stories concerning foodborne illnesses and natural disasters (Parmer et al., 2016). The analysis found that news outlets focus on information and explanation, with little coverage of expressions of empathy, although the above evidence suggests empathy is important during crises.

A primary aspect of crisis communication is to inform and update citizens about risk. From a behavioral perspective, this is difficult territory. Downplaying risk may undermine efforts to change behavior, but overstating it could increase economic and social costs. Moreover, different people have different tolerance for risk; there is no "right" response to a given level of risk. The issue is vital because there is strong evidence from meta-analyses to suggest that risk perception drives behavioral responses (Sheeran, Harris, & Epton, 2014). Moreover, following a change in behavior, people tend to adjust their perception of risk downwards (Brewer et al., 2004). However, individuals struggle to perceive risks accurately and distort probability when making decisions (Kahneman & Tversky, 2000), with substantial

differences between individuals (Fehr-Duda & Epper, 2012). Nevertheless, many effects are known and can be taken into consideration when trying to communicate risk faithfully.

People judge the likelihood of an outcome partly by how easily it springs to mind (Tversky & Kahneman, 1973). This "availability heuristic" biases perceptions of lethal risks, increasing the perceived likelihood of evocative outcomes and those emphasized by the media (Lichtenstein et al., 1978). Perceptions of risk and protective behaviors tend to track the volume of coverage on traditional and social media (Chan et al., 2018). Risks are judged to be greater when they have more emotional impact – the "affect heuristic" (Finucane et al., 2000). Fear tends to increase perception of risk, while anger can reduce it (Lerner et al., 2003). Availability and affect heuristics can operate together (Pachur, Hertwig, & Steinmann, 2012). Overall, there is no established dynamic for how risks to the public are perceived over time; some provoke excessive response, others insufficient (Loewenstein & Mather, 1990).

A bias that may be particularly important for authorities during a crisis is "hindsight bias". Information regarding the coronavirus will continue to evolve, leading to constant revisions of assessments. Compared to their assessment beforehand, people generally believe that an outcome was always more likely once they know that it happened (Fischhoff, 2003). Over months, or even weeks, this may lead to a perception that the authorities "should have known" where events were heading, when in reality uncertainty was great. Being clear about the extent of uncertainty and reminding people of that uncertainty may be important for credibility.

Knowing these biases, one might strive to communicate numeric estimates of risk. People trust numbers more and most (but not all) people prefer them (Trevena et al., 2006). However, even numbers can be framed in ways that make risks appear larger or smaller, including via positive and negative framing (e.g. 2% mortality versus 98% survival) (Peters, Hart, & Fraenkel, 2011), leading some to argue that both should be used (Gigerenzer, 2014).

An important issue is how to communicate uncertainty. The impact of COVID-19 is, and will remain, hard to assess. Hindsight bias is likely as the situation becomes clearer. Stating a cautious range is one solution. However, a trade-off exists: ranges imply honesty, but can undermine the perceived expertise of decision-makers (Johnson & Slovic, 1995). In addition, many people think of the distribution underlying a range as uniform, like drawing lottery balls, rather than understanding that numbers near the middle are more likely (Dieckmann, Peters, & Gregory, 2015). There is an argument for countering this bias directly. Thus, a reasonable framing for a projected number of infections in a locality might be to state, for example: "At this stage our projection is for anything ranging from 3,000 to 22,000, but based on current evidence we think a figure in the region of 12,000 is most likely."

Overall, the evidence provides some clear principles for communicating health crisis information. In addition to speed, honesty, and credibility, it is important to stress the usefulness of individual actions and decisions. Empathy matters – people need reassurance that those in charge understand how they feel. Using multiple platforms and tailoring some key messages to subgroups is likely to be beneficial too, although social media has not generally proved effective for official communication during outbreaks. While there is no

uncontested "best practice" for communicating public health risks (Zipkin et al., 2014), there are lessons. These include not using specific or extreme cases, avoiding emotive language (beyond expressing empathy), and sticking dispassionately to numbers. Communicating uncertainty via ranges is honest, but it should be emphasized that the middle is most likely. Stating ranges as maximums (e.g. "anything up to 22,000" in the example above) will exacerbate upward bias. While the aim here is primarily to inform authorities, these lessons apply equally to media reporting.

Discussion and Conclusion

The evidence described and interpreted in this review was rapidly assembled to address five topics where behavioral science might make a constructive contribution to fighting COVID-19. The evidence varies in volume and strength and, therefore, in the definitiveness with which conclusions can be drawn. We summarize the main findings and the strength of the evidence for each in Table 1.

Regarding individual behaviors, evidence on placement of hand sanitizers is strong and straightforwardly points to behavioral interventions that, if sufficiently widespread, are likely to slow transmission. By contrast, evidence concerning face touching is scant and we must fall back on general models of behavior change. Evidence regarding self-isolation is also indicative. At the time of writing, the psychological impact of self-isolation and the potential for disincentives to self-isolate may be being underestimated. An informal scan of public advice in multiple countries reveals that all are advising self-isolation with little mention of

available support. The good news is that there are evidence-based behavioral techniques available: engaging social contacts when entering isolation and planning a daily routine.

Turning to broader principles for collective behavior, we identified three effects that have strong supporting evidence from studies in multiple contexts. Co-operation is more likely where there is communication of the common strategy, stronger group identity, and proportionate disapproval or punishment. These principles apply to multiple aspects of the pandemic, from encouraging good sanitation and necessary self-isolation to discouraging panic buying and xenophobia.

Our conclusions on effective crisis communication are more nuanced and reached on the balance of probabilities. Speed, honesty, and credibility are good, but empathy and promoting individual action matter too. At the national level, the evidence suggests that these last two are more likely to get caught in the media filter, so may need greater emphasis. The evidence on risk communication is clearest about what not to do – avoiding extreme cases, emotive language, and stating worst case scenarios. Dispassionate numbers with ranges are probably best.

This review is organized by specific topic, but there are three important cross-cutting behavioral principles to keep in mind. First, evidence-based behavioral interventions can be combined. An organization seeking to improve hand hygiene can place one or more sanitizers directly inside its front door with a red "stop" sign, making it unmissable to all who enter. The receptionist's first words can be "have you used the hand sanitizer?" Thus,

an intervention known to be effective can be combined with a method to capture attention, the enforcement of a social norm, and likely social disapproval for those who don't co-operate, because the behavior is in public spaces.

Second, across multiple areas of behavioral science, there are benefits to be had from keeping things simple. Even when strongly motivated, people cannot retain large volumes of information; mental bandwidth is limited. The principle is inherent in the previous example. Each intervention is simple and sequentially separated, hence likely to be more effective than a poster or leaflet describing multiple benefits of handwashing.

Third, an important principle of applied behavioral science warrants mention. A number of studies cited here exemplify the possibilities for pre-testing interventions for effectiveness. Even when time is short, rapid testing of comprehension and public responses to health materials can be undertaken. While laboratory studies and field trials may be more difficult than usual in places where social distancing measures have been introduced, interventions based on advice and persuasive communications can be tested online, using high-quality experimental methods.

Looking across the five areas surveyed by this paper, the effectiveness of communication stands out as a crucial issue in generating desirable behavior. Yet a large proportion of communication from public authorities, naturally, passes through the filter of the media. Several findings covered in the body of this paper apply. In particular, there is evidence that media reports focus primarily on the latest levels of threat, as they might in normal times.

However, one can make a reasonable case that during a health crisis, the role of the media should change somewhat, as it does during other periods such as elections. From a behavioral perspective, it would be helpful to increase coverage of actions that people can and should take to reduce risk, or of utterances of responsible individuals that may communicate empathy or credibility – factors that evidence suggests are important to subsequent behavior. There may be personal and societal benefits to giving more time than usual to advice, constructive personal actions, and direct communications between authorities and citizens. Given the volume of coverage on COVID-19, this can be done without affecting the ability of the media to fulfil its functions in faithfully reporting events and holding the powerful to account.

At the time of writing, unfortunately, it seems that COVID-19 will afflict people around the world for months and perhaps years. There will be multiple opportunities for behavioral science to contribute to the fight against it. We hope this review makes an initial contribution to that effort.

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References

Abramson, D., & Piltch-Loeb, R. (2016). U.S. Public's perception of Zika risk: Awareness, knowledge, and receptivity to public health interventions. *New York University Briefing Report*. Avaliable at: https://www.nyu.edu/content/dam/nyu/publicAffairs/documents/PDF/research/PiR2_Zika_Report_rf.pdf [Last accessed: 11/03/2020)

Anderson, R. M., Heesterbeek, H., Klinkenberg, D., & Hollingsworth, T. D. (2020). How will country-based mitigation measures influence the course of the COVID-19 epidemic? *The Lancet*, Published online. https://doi.org/10.1016/S0140-6736(20)30567-5

Böhm, R., Rusch, H., & Baron, J. (2018). The psychology of intergroup conflict: A review of theories and measures. *Journal of Economic Behavior and Organization*, published online, https://doi.org/10.1016/j.jebo.2018.01.020

Bonneux, L., & Damme, W. V. (2006). An iatrogenic pandemic of panic. *BMJ*, *332*(7544), 786–788. https://doi.org/10.1136/bmj.332.7544.786

Bornstein, G. (1992). Group decision and individual choice in intergroup competition for public goods. In W. Leibrand, D. Messick, & H. Wilke (Eds.), *Social dilemmas: Theoretical issues and research findings* (pp. 247-263). Oxford, UK: Pergamon Press.

Bovet, A., & Makse, H. A. (2019). Influence of fake news in Twitter during the 2016 US presidential election. *Nature Communications*, 10(1), 1-14.

Brewer, N. T., Weinstein, N. D., Cuite, C. L., & Herrington, J. E. (2004). Risk perceptions and their relation to risk behavior. *Annals of Behavioral Medicine*, *27*(2), 125–130. https://doi.org/10.1207/s15324796abm2702_7

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *The Lancet*, *395*(10227), 912–920. https://doi.org/10.1016/S0140-6736(20)30460-8

Cacioppo, S., Capitanio, J. P., & Cacioppo, J. T. (2014). Toward a neurology of loneliness. *Psychological Bulletin*, 140(6), 1464. https://doi.org/10.1037/0882-7974.21.1.140

Carter, H., Drury, J., Rubin, G. J., Williams, R., & Amlôt, R. (2013). The effect of communication during mass decontamination. *Disaster Prevention and Management: An International Journal*, *22*(2), 132–147. https://doi.org/10.1108/09653561311325280

Chan, B. P., Homa, K., & Kirkland, K. B. (2013). Effect of Varying the Number and Location of Alcohol-Based Hand Rub Dispensers on Usage in a General Inpatient Medical

Unit. *Infection Control and Hospital Epidemiology*, *34*(9), 987–989. https://doi.org/10.1086/671729

Chan, M. S., Winneg, K., Hawkins, L., Farhadloo, M., Jamieson, K. H., & Albarracín, D. (2018). Legacy and social media respectively influence risk perceptions and protective behaviors during emerging health threats: A multi-wave analysis of communications on Zika virus cases. *Social Science and Medicine*, *212*, 50–59. https://doi.org/10.1016/j.socscimed.2018.07.007

Chaudhuri, A. (2011). Sustaining cooperation in laboratory public goods experiments: A selective survey of the literature. *Experimental Economics*, *14*(1), 47–83. https://doi.org/10.1007/s10683-010-9257-1

Chekroud, S. R., Gueorguieva, R., Zheutlin, A. B., Paulus, M., Krumholz, H. M., Krystal, J. H., & Chekroud, A. M. (2018). Association between physical exercise and mental health in 1·2 million individuals in the USA between 2011 and 2015: A cross-sectional study. *The Lancet Psychiatry*, *5*(9), 739–746. https://doi.org/10.1016/S2215-0366(18)30227-X

Cure, L., & Van Enk, R. (2015). Effect of hand sanitizer location on hand hygiene compliance. *American Journal of Infection Control*, *43*(9), 917–921. https://doi.org/10.1016/j.ajic.2015.05.013

Danenberg, N. (2018, February 26). Why Public Health Campaigns Often Neglect the Simple Rules of Advertising. Ehrenberg-Bass Institute for Marketing Science. Retrieved March 11, 2020, from https://www.marketingscience.info/public-health-campaigns-often-neglect-simple-rules-advertising/

Day, T., Park, A., Madras, N., Gumel, A., & Wu, J. (2006). When Is Quarantine a Useful Control Strategy for Emerging Infectious Diseases? *American Journal of Epidemiology*, *163*(5), 479–485. https://doi.org/10.1093/aje/kwj056

Dieckmann, N. F., Peters, E., & Gregory, R. (2015). At Home on the Range? Lay Interpretations of Numerical Uncertainty Ranges. *Risk Analysis*, *35*(7), 1281–1295. https://doi.org/10.1111/risa.12358

Edwards, R., Charani, E., Sevdalis, N., Alexandrou, B., Sibley, E., Mullett, D., Loveday, H. P., Drumright, L. N., & Holmes, A. (2012). Optimisation of infection prevention and control in acute health care by use of behaviour change: A systematic review. *The Lancet Infectious Diseases*, *12*(4), 318–329. https://doi.org/10.1016/S1473-3099(11)70283-3

Fehr, E., & Gächter, S. (2000). Cooperation and Punishment in Public Goods Experiments. *American Economic Review*, *90*(4), 980–994. https://doi.org/10.1257/aer.90.4.980

Fehr, E., & Schurtenberger, I. (2018). Normative foundations of human cooperation. *Nature Human Behaviour*, *2*(7), 458–468. https://doi.org/10.1038/s41562-018-0385-5

Fehr-Duda, H., & Epper, T. (2012). Probability and Risk: Foundations and Economic Implications of Probability-Dependent Risk Preferences. *Annual Review of Economics*, *4*(1), 567–593. https://doi.org/10.1146/annurev-economics-080511-110950

Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making*, *13*(1), 1–17. https://doi.org/10.1002/(SICI)1099-0771(200001/03)13:1<1::AID-BDM333>3.0.CO;2-S

Fischhoff, B. (2003). Hindsight ≠ foresight: The effect of outcome knowledge on judgment under uncertainty. *BMJ Quality and Safety*, *12*(4), 304–311. https://doi.org/10.1136/qhc.12.4.304

Ford, E. W., Boyer, B. T., Menachemi, N., & Huerta, T. R. (2013). Increasing Hand Washing Compliance With a Simple Visual Cue. *American Journal of Public Health*, *104*(10), 1851–1856. https://doi.org/10.2105/AJPH.2013.301477

Gardner, B., Lally, P., & Wardle, J. (2012). Making health habitual: The psychology of 'habit-formation' and general practice. *British Journal of General Practice*, *62*(605), 664–666. https://doi.org/10.3399/bjgp12X659466

Gigerenzer, G. (2014). Should patients listen to how doctors frame messages? *BMJ*, *349*. https://doi.org/10.1136/bmj.g7091

Gollwitzer, P. M. (1999). Implementation intentions: strong effects of simple plans. *American Psychologist*, 54(7), 493. https://doi.org/10.1037/0003-066X.54.7.493

Gould, D. J., Moralejo, D., Drey, N., Chudleigh, J. H., & Taljaard, M. (2017). Interventions to improve hand hygiene compliance in patient care. *Cochrane Database of Systematic Reviews*, *9*. https://doi.org/10.1002/14651858.CD005186.pub4

Hallsworth, M. (2020, March 5). How to stop touching our faces in the wake of the Coronavirus. Retrieved March 11, 2020, from https://www.bi.team/blogs/how-to-stop-touching-our-faces-in-the-wake-of-the-coronavirus/

Haushofer, J. and Metcalf, J.C.E. (2020). Combining behavioral economics and infectious disease epidemiology to mitigate the COVID-19 outbreak. Working Paper, Princeton University.

Hawryluck, L., Gold, W. L., Robinson, S., Pogorski, S., Galea, S., & Styra, R. (2004). SARS Control and Psychological Effects of Quarantine, Toronto, Canada. *Emerging Infectious Diseases*, *10*(7), 1206–1212. https://doi.org/10.3201/eid1007.030703

Heath, R. L., Lee, J., & Ni, L. (2009). Crisis and Risk Approaches to Emergency Management Planning and Communication: The Role of Similarity and Sensitivity. *Journal of Public Relations Research*, *21*(2), 123–141. https://doi.org/10.1080/10627260802557415

Herrmann, B., Thöni, C., & Gächter, S. (2008). Antisocial Punishment Across Societies. *Science*, *319*(5868), 1362–1367. https://doi.org/10.1126/science.1153808

Hobbs, M. A., Robinson, S., Neyens, D. M., & Steed, C. (2016). Visitor characteristics and alcohol-based hand sanitizer dispenser locations at the hospital entrance: Effect on visitor use rates. *American Journal of Infection Control*, *44*(3), 258–262. https://doi.org/10.1016/j.ajic.2015.10.041

Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and Social Isolation as Risk Factors for Mortality: A Meta-Analytic Review. *Perspectives on Psychological Science*, *10*(2), 227–237. https://doi.org/10.1177/1745691614568352

Hopman, J., Allegranzi, B., & Mehtar, S. (2020). Managing COVID-19 in Low-and Middle-Income Countries. *JAMA*, published online. doi:10.1001/jama.2020.4169

Huis, A., van Achterberg, T., de Bruin, M., Grol, R., Schoonhoven, L., & Hulscher, M. (2012). A systematic review of hand hygiene improvement strategies: A behavioural approach. *Implementation Science*, *7*(1), 92. https://doi.org/10.1186/1748-5908-7-92

Irish, L. A., Kline, C. E., Gunn, H. E., Buysse, D. J., & Hall, M. H. (2015). The role of sleep hygiene in promoting public health: A review of empirical evidence. *Sleep Medicine Reviews*, *22*, 23–36. https://doi.org/10.1016/j.smrv.2014.10.001

Jeong, H., Yim, H. W., Song, Y.-J., Ki, M., Min, J.-A., Cho, J., & Chae, J.-H. (2016). Mental health status of people isolated due to Middle East Respiratory Syndrome. *Epidemiology and Health*, *38*. https://doi.org/10.4178/epih.e2016048

Jin, Y., Austin, L., Vijaykumar, S., Jun, H., & Nowak, G. (2019). Communicating about infectious disease threats: Insights from public health information officers. *Public Relations Review*, *45*(1), 167–177. https://doi.org/10.1016/j.pubrev.2018.12.003

Johnson, B. B., & Slovic, P. (1995). Presenting Uncertainty in Health Risk Assessment: Initial Studies of Its Effects on Risk Perception and Trust. *Risk Analysis*, *15*(4), 485–494. https://doi.org/10.1111/j.1539-6924.1995.tb00341.x

Judah, G., Aunger, R., Schmidt, W.-P., Michie, S., Granger, S., & Curtis, V. (2009). Experimental Pretesting of Hand-Washing Interventions in a Natural Setting. *American Journal of Public Health*, *99*(S2), S405–S411. https://doi.org/10.2105/AJPH.2009.164160

Kahneman, D. and Tversky, A. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 5, 207-232. https://doi.org/10.1016/0010-0285(73)90033-9

Kahneman, D. and Tversky, A. (2000). *Choices, values and frames*. Cambridge: CUP.

Kahneman, D. (2011). *Thinking, fast and slow*. New York and London: Penguin.

Kalichman, S. C., & Coley, B. (1995). Context framing to enhance HIV-antibody-testing messages targeted to African American women. *Health Psychology*, *14*(3), 247–254. https://doi.org/10.1037/0278-6133.14.3.247

Kappes, A., Nussberger, A.-M., Faber, N. S., Kahane, G., Savulescu, J., & Crockett, M. J. (2018). Uncertainty about the impact of social decisions increases prosocial behaviour. *Nature Human Behaviour*, *2*(8), 573–580. https://doi.org/10.1038/s41562-018-0372-x

Karan, A. (2020, March 4). Abraar Karan: To control the covid-19 outbreak, young, healthy patients should avoid the emergency room. The BMJ. Retrieved March 11, 2020, from https://blogs.bmj.com/bmj/2020/03/04/abraar-karan-control-covid19-outbreak-young-healthy-patients-should-avoid-emergency-room/

Kass-Hout, T. A., & Alhinnawi, H. (2013). Social media in public health. *British Medical Bulletin*, *108*(1), 5–24. https://doi.org/10.1093/bmb/ldt028

Kilgo, D. K., Yoo, J., & Johnson, T. J. (2019). Spreading Ebola Panic: Newspaper and Social Media Coverage of the 2014 Ebola Health Crisis. *Health Communication*, *34*(8), 811–817. https://doi.org/10.1080/10410236.2018.1437524

Klemm, C., Das, E., & Hartmann, T. (2016). Swine flu and hype: A systematic review of media dramatization of the H1N1 influenza pandemic. *Journal of Risk Research*, *19*(1), 1–20. https://doi.org/10.1080/13669877.2014.923029

Kwok, Y. L. A., Gralton, J., & McLaws, M.-L. (2015). Face touching: A frequent habit that has implications for hand hygiene. *American Journal of Infection Control*, *43*(2), 112–114. https://doi.org/10.1016/j.ajic.2014.10.015

Lapinski, M. K., Maloney, E. K., Braz, M., & Shulman, H. C. (2013). Testing the Effects of Social Norms and Behavioral Privacy on Hand Washing: A Field Experiment. *Human Communication Research*, *39*(1), 21–46. https://doi.org/10.1111/j.1468-2958.2012.01441.x

Ledyard, O. (1995). Public goods: some experimental results. In J. Kagel & A. Roth (Eds.), *Handbook of experimental economics*. Princeton: Princeton University Press (Chap. 2).

Lee, A. Y. (2001). The Mere Exposure Effect: An Uncertainty Reduction Explanation Revisited. *Personality and Social Psychology Bulletin*, *27*(10), 1255–1266. https://doi.org/10.1177/01461672012710002

Lee, S., Chan, L. Y. Y., Chau, A. M. Y., Kwok, K. P. S., & Kleinman, A. (2005). The experience of SARS-related stigma at Amoy Gardens. *Social Science and Medicine*, *61*(9), 2038–2046. https://doi.org/10.1016/j.socscimed.2005.04.010

Lerner, J. S., Gonzalez, R. M., Small, D. A., & Fischhoff, B. (2003). Effects of Fear and Anger on Perceived Risks of Terrorism: A National Field Experiment. *Psychological Science*, *14*(2), 144–150. https://doi.org/10.1111/1467-9280.01433

Lichtenstein, S., Slovic, P., Fischhoff, B., Layman, M., & Combs, B. (1978). Judged frequency of lethal events. *Journal of Experimental Psychology: Human Learning and Memory*, *4*(6), 551–578. https://doi.org/10.1037/0278-7393.4.6.551

Lipinski, D., & Nelson, R. (1974). The reactivity and unreliability of self-recording. *Journal of Consulting and Clinical Psychology*, *42*(1), 118–123. https://doi.org/10.1037/h0036059

Liu, X., Kakade, M., Fuller, C. J., Fan, B., Fang, Y., Kong, J., Guan, Z., & Wu, P. (2012). Depression after exposure to stressful events: Lessons learned from the severe acute respiratory syndrome epidemic. *Comprehensive Psychiatry*, *53*(1), 15–23. https://doi.org/10.1016/j.comppsych.2011.02.003

Loewenstein, G., & Mather, J. (1990). Dynamic processes in risk perception. *Journal of Risk and Uncertainty*, *3*(2), 155–175. https://doi.org/10.1007/BF00056370

Lyall, L. M., Wyse, C. A., Graham, N., Ferguson, A., Lyall, D. M., Cullen, B., Celis Morales, C. A., Biello, S. M., Mackay, D., Ward, J., Strawbridge, R. J., Gill, J. M. R., Bailey, M. E. S., Pell, J. P., & Smith, D. J. (2018). Association of disrupted circadian rhythmicity with mood disorders, subjective wellbeing, and cognitive function: A cross-sectional study of 91 105 participants from the UK Biobank. *The Lancet Psychiatry*, *5*(6), 507–514. https://doi.org/10.1016/S2215-0366(18)30139-1

Marjanovic, Z., Greenglass, E. R., & Coffey, S. (2007). The relevance of psychosocial variables and working conditions in predicting nurses' coping strategies during the SARS crisis: An online questionnaire survey. *International Journal of Nursing Studies*, *44*(6), 991–998. https://doi.org/10.1016/j.ijnurstu.2006.02.012

Masclet, D., Noussair, C., Tucker, S., & Villeval, M.-C. (2003). Monetary and Nonmonetary Punishment in the Voluntary Contributions Mechanism. *American Economic Review*, *93*(1), 366–380. https://doi.org/10.1257/000282803321455359

Maunder, R., Hunter, J., Vincent, L., Bennett, J., Peladeau, N., Leszcz, M., Sadavoy, J., Verhaeghe, L. M., Steinberg, R., & Mazzulli, T. (2003). The immediate psychological and occupational impact of the 2003 SARS outbreak in a teaching hospital. *CMAJ*, *168*(10), 1245–1251.

Mawson, A. R. (2005). Understanding Mass Panic and Other Collective Responses to Threat and Disaster. *Psychiatry: Interpersonal and Biological Processes*, *68*(2), 95–113. https://doi.org/10.1521/psyc.2005.68.2.95

Michie, S. (2020, March 3). *Behavioural strategies for reducing covid-19 transmission in the general population*. The BMJ. https://blogs.bmj.com/bmj/2020/03/03/behavioural-strategies-for-reducing-covid-19-transmission-in-the-general-population/

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42. https://doi.org/10.1186/1748-5908-6-42

Montague, M., Borland, R., & Sinclair, C. (2001). Slip! Slop! Slap! and SunSmart, 1980-2000: Skin Cancer Control and 20 Years of Population-Based Campaigning. *Health Education & Behavior*, *28*(3), 290–305. https://doi.org/10.1177/109019810102800304

Naikoba, S., & Hayward, A. (2001). The effectiveness of interventions aimed at increasing handwashing in healthcare workers—A systematic review. *Journal of Hospital Infection*, *47*(3), 173–180. https://doi.org/10.1053/jhin.2000.0882

Navarrete, C. D., & Fessler, D. M. T. (2006). Disease avoidance and ethnocentrism: The effects of disease vulnerability and disgust sensitivity on intergroup attitudes. *Evolution and Human Behavior*, *27*(4), 270–282. https://doi.org/10.1016/j.evolhumbehav.2005.12.001

OECD. (2017). *Behavioural Insights and Public Policy: Lessons from Around the World*. OECD. https://doi.org/10.1787/9789264270480-en

Oh, S.H., Lee, S. Y., & Han, C. (2020). The Effects of Social Media Use on Preventive Behaviors during Infectious Disease Outbreaks: The Mediating Role of Self-relevant Emotions and Public Risk Perception. *Health Communication*, published online. https://doi.org/10.1080/10410236.2020.1724639

Ostrom, E., Walker, J., & Gardner, R. (1992). Covenants with and without a sword: Self-governance is possible. *American Political Science Review*, 86(2), 404-417. https://doi.org/10.2307/1964229

Pachur, T., Hertwig, R., & Steinmann, F. (2012). How do people judge risks: Availability heuristic, affect heuristic, or both? *Journal of Experimental Psychology: Applied*, *18*(3), 314–330. https://doi.org/10.1037/a0028279

Parmer, J., Baur, C., Eroglu, D., Lubell, K., Prue, C., Reynolds, B., & Weaver, J. (2016). Crisis and Emergency Risk Messaging in Mass Media News Stories: Is the Public Getting the Information They Need to Protect Their Health? *Health Communication*, *31*(10), 1215–1222. https://doi.org/10.1080/10410236.2015.1049728

Pavitt, C. (2018). The Path to Cooperative Action during Group Social Dilemmas: A Literature Review, Set of Propositions, and Model Describing How the Opportunity to Communicate Encourages Cooperation. *Review of Communication Research*, *6*, 54–83. https://doi.org/10.12840/issn.2255-4165.2018.06.01.016

Person, B., Sy, F., Holton, K., Govert, B., Liang, A., Garza, B., Gould, D., Hickson, M., McDonald, M., Meijer, C., Smith, J., Veto, L., Williams, W., & Zauderer, L. (2004). Fear and Stigma: The Epidemic within the SARS Outbreak. *Emerging Infectious Diseases*, *10*(2), 358–363. https://doi.org/10.3201/eid1002.030750

Peters, E., Hart, P. S., & Fraenkel, L. (2011). Informing Patients: The Influence of Numeracy, Framing, and Format of Side Effect Information on Risk Perceptions. *Medical Decision Making*, *31*(3), 432–436. https://doi.org/10.1177/0272989X10391672

Peters, G.J. Y., Ruiter, R. A. C., Hoor, G. A. ten, Kessels, L. T. E., & Kok, G. (2018). Towards consensus on fear appeals: A rejoinder to the commentaries on Kok, Peters, Kessels, ten Hoor, and Ruiter (2018). *Health Psychology Review*, *12*(2), 151–156. https://doi.org/10.1080/17437199.2018.1454846

Porzig-Drummond, R., Stevenson, R., Case, T., & Oaten, M. (2009). Can the emotion of disgust be harnessed to promote hand hygiene? Experimental and field-based tests. *Social Science and Medicine*, *68*(6), 1006–1012. https://doi.org/10.1016/j.socscimed.2009.01.013

Rashidi, B., Li, A., Patel, R., Harmsen, I. E., Sabri, E., Kyeremanteng, K., & D'Egidio, G. (2016). Effectiveness of an extended period of flashing lights and strategic signage to increase the salience of alcohol-gel dispensers for improving hand hygiene compliance. *American Journal of Infection Control*, *44*(7), 782–785. https://doi.org/10.1016/j.ajic.2016.01.002

Reynolds, B. J. (2011). When the facts are just not enough: Credibly communicating about risk is riskier when emotions run high and time is short. *Toxicology and Applied Pharmacology*, *254*(2), 206–214. https://doi.org/10.1016/j.taap.2010.10.023

Rona, R. J., Fear, N. T., Hull, L., Greenberg, N., Earnshaw, M., Hotopf, M., & Wessely, S. (2007). Mental health consequences of overstretch in the UK armed forces: First phase of a cohort study. *BMJ*, *335*(7620), 603. https://doi.org/10.1136/bmj.39274.585752.BE

Rubin, G. J., Potts, H. W. W., & Michie, S. (2010). The impact of communications about swine flu (influenza A H1N1v) on public responses to the outbreak: Results from 36 national telephone surveys in the UK. *Health Technology Assessment (Winchester, England)*, *14*(34), 183–266. https://doi.org/10.3310/hta14340-03

Romaniuk, J., & Sharp, B. (2004). Conceptualizing and measuring brand salience. *Marketing Theory*, 4(4), 327-342. https://doi.org/10.1177/1470593104047643

Shaw, L. H., & Gant, L. M. (2002). In Defense of the Internet: The Relationship between Internet Communication and Depression, Loneliness, Self-Esteem, and Perceived Social Support. *CyberPsychology and Behavior*, *5*(2), 157–171. https://doi.org/10.1089/109493102753770552

Sheeran, P., Harris, P. R., & Epton, T. (2014). Does heightening risk appraisals change people's intentions and behavior? A meta-analysis of experimental studies. *Psychological Bulletin*, *140*(2), 511–543. https://doi.org/10.1037/a0033065

Shen, L. (2010). Mitigating Psychological Reactance: The Role of Message-Induced Empathy in Persuasion. *Human Communication Research*, *36*(3), 397–422. https://doi.org/10.1111/j.1468-2958.2010.01381.x

Shen, L. (2015). Targeting Smokers With Empathy Appeal Antismoking Public Service Announcements: A Field Experiment. *Journal of Health Communication*, *20*(5), 573–580. https://doi.org/10.1080/10810730.2015.1012236

Shimizu, K. (2020). 2019-nCoV, fake news, and racism. *The Lancet*, 395(10225), 685-686. https://doi.org/10.1016/S0140-6736(20)30358-5

Sniehotta, F. F., Schwarzer, R., Scholz, U., & Schüz, B. (2005). Action planning and coping planning for long-term lifestyle change: Theory and assessment. *European Journal of Social Psychology*, *35*(4), 565–576. https://doi.org/10.1002/ejsp.258

Sohrabi, C., Alsafi, Z., O'Neill, N., Khan, M., Kerwan, A., Al-Jabir, A., Iosifidis, C., & Agha, R. (2020). World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). *International Journal of Surgery*, *76*, 71–76. https://doi.org/10.1016/j.ijsu.2020.02.034

Sunstein, C.R. (2011). Empirically Informed Regulation. *University of Chicago Law Review*, 78, 1348-1429.

Sweeny, K., Melnyk, D., Miller, W., & Shepperd, J. A. (2010). Information Avoidance: Who, What, When, and Why. *Review of General Psychology*, *14*(4), 340–353. https://doi.org/10.1037/a0021288

Tannenbaum, M. B., Hepler, J., Zimmerman, R. S., Saul, L., Jacobs, S., Wilson, K., & Albarracín, D. (2015). Appealing to fear: A meta-analysis of fear appeal effectiveness and theories. *Psychological Bulletin*, *141*(6), 1178–1204. https://doi.org/10.1037/a0039729

Thaler, R.H. and Sunstein, C.R. (2008). *Nudge: improving decisions about health, wealth, and happiness*. Yale University Press.

Toppenberg-Pejcic, D., Noyes, J., Allen, T., Alexander, N., Vanderford, M., & Gamhewage, G. (2019). Emergency Risk Communication: Lessons Learned from a Rapid Review of

Recent Gray Literature on Ebola, Zika, and Yellow Fever. *Health Communication*, *34*(4), 437–455. https://doi.org/10.1080/10410236.2017.1405488

Trevena, L. J., Barratt, A., Butow, P., & Caldwell, P. (2006). A systematic review on communicating with patients about evidence. *Journal of Evaluation in Clinical Practice*, *12*(1), 13–23. https://doi.org/10.1111/j.1365-2753.2005.00596.x

Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, *5*(2), 207–232. https://doi.org/10.1016/0010-0285(73)90033-9

Van Der Linden, S.. (2015). Intrinsic motivation and pro-environmental behaviour. *Nature Climate Change*, *5*(7), 612–613. https://doi.org/10.1038/nclimate2669

Vaughan, E., & Tinker, T. (2009). Effective Health Risk Communication About Pandemic Influenza for Vulnerable Populations. *American Journal of Public Health*, *99*(S2), S324–S332. https://doi.org/10.2105/AJPH.2009.162537

Wahl-Jorgensen, K. (2020). Coronavirus: how media coverage of epidemics often stokes fear and panic. Available at: https://theconversation.com/coronavirus-how-media-coverage-of-epidemics-often-stokes-fear-and-panic-131844 [Accessed: 09/03/2020].

Wang, G., Zhang, Y., Zhao, J., Zhang, J., & Jiang, F. (2020). Mitigate the effects of home confinement on children during the COVID-19 outbreak. *The Lancet*. https://doi.org/10.1016/S0140-6736(20)30547-X

Wu, P., Liu, X., Fang, Y., Fan, B., Fuller, C. J., Guan, Z., Yao, Z., Kong, J., Lu, J., & Litvak, I. J. (2008). Alcohol Abuse/Dependence Symptoms Among Hospital Employees Exposed to a SARS Outbreak. *Alcohol and Alcoholism*, *43*(6), 706–712. https://doi.org/10.1093/alcalc/agn073

Zelmer, J. (2003). Linear Public Goods Experiments: A Meta-Analysis. *Experimental Economics*, *6*(3), 299–310. https://doi.org/10.1023/A:1026277420119

Zipkin, D. A., Umscheid, C. A., Keating, N. L., Allen, E., Aung, K., Beyth, R., Kaatz, S., Mann, D. M., Sussman, J. B., Korenstein, D., Schardt, C., Nagi, A., Sloane, R., & Feldstein, D. A. (2014). Evidence-Based Risk Communication: A Systematic Review. *Annals of Internal Medicine*, *161*(4), 270. https://doi.org/10.7326/M14-0295

Zivich, P. N., Gancz, A. S., & Aiello, A. E. (2018). Effect of hand hygiene on infectious diseases in the office workplace: A systematic review. *American Journal of Infection Control*, *46*(4), 448–455. https://doi.org/10.1016/j.ajic.2017.10.006