



Linking knowledge with action when engagement is out of reach: three contextual features of effective public health communication

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Abstract

Scholars and practitioners often promote direct engagement between policymakers, health workers and researchers as a strategy for overcoming barriers to utilizing scientific knowledge in health policy. However, in many settings public health officials rarely have opportunities to interact with researchers, which is a problem further exacerbated by the coronavirus disease 2019 pandemic. One prominent theory argues that policy actors will trust and utilize research findings when they perceive them to be salient, credible and legitimate. We draw on this theory to examine the conditions facilitating greater uptake of new knowledge among health officials when engagement is out of reach and they are instead exposed to new ideas through written mass communication. Using data from a survey experiment with about 260 health workers and administrators in Honduras, we find that messages from a technocratic sender based on statistical evidence improved perceptions of salience, credibility and legitimacy (SCL). Additionally, perceptions of SCL are three contextual features that operate as joint mediators between knowledge and action, and several individual characteristics also influence whether officials trust research findings enough to apply them when formulating and implementing health policies. This research can help inform the design of context-sensitive knowledge translation and exchange strategies to advance the goals of evidence-based public health, particularly in settings where direct engagement is difficult to achieve.

Keywords: Evidence-based public health, knowledge translation, research to policy, health communication, sustainability science, Latin America

Introduction

Scientific research produces a wealth of knowledge about potential solutions to important social problems and global health challenges. Unfortunately, this information often fails to find its way into decision-makers' hands (van Kerkhoff and Lebel, 2006). And even when it does, that information may not always be translated into action because civil servants and practitioners have considerable discretion in utilizing scientific findings for crafting and carrying out public policies (Lipsky, 1980; Brodtkin, 1990). As such, references to the knowledge-to-action gap are now prominent across numerous policy domains, including healthcare (Nobel, 2006; Michie *et al.*, 2020). Addressing this gap so there is more effective linking of scientific knowledge with policy action is imperative for helping governments meet the health needs of their populations and advancing human development goals globally (Brundtland, 1997; Clark *et al.*, 2016b; Matson *et al.*, 2016; Clark and Harley, 2020).

Studies in the literatures on Evidence-Based Practice and Policy (EBP) and Science Communication often begin by recognizing that researchers have already produced a great deal of knowledge, but there are significant barriers that prevent

members of the policy community and the general public from accessing and making use of this information in their decision-making (Hennink and Stephenson, 2005; Nutley *et al.*, 2007; Ferlie *et al.*, 2012; Majdzadeh *et al.*, 2012; Lupia, 2013). Accordingly, a major goal of both of these literatures is to identify effective strategies for the dissemination of existing scientific knowledge to as many individuals as possible. For example, the science communication literature on preventative health makes efforts to use scientific findings to motivate population-level behavioural changes, such as encouraging people to stop smoking and drink less alcohol, or, during viral outbreaks, wear masks while maintaining physical distance (Snyder *et al.*, 2004; Noar, 2006; Naugle and Hornik, 2014). Similarly, EBP often focuses on translating research findings for a wide range of decision-makers or disseminating best practices across numerous organizations (Oliver *et al.*, 2014; Ongolo-Zogo *et al.*, 2018). Both literatures emphasize the need to consider contextual factors, such as demographic and professional attributes of the knowledge users or aspects of the policy problem itself, as part of designing effective knowledge dissemination campaigns (Dobrow *et al.*, 2004; Noar, 2006; Naugle and Hornik, 2014; Mosley *et al.*, 2019).

Key messages

- Bridging science communication, evidence-based practice and co-production perspectives, our study introduces a more nuanced view of how knowledge users come to trust and adopt new evidence when implementing public health policies based on three contextual features of public health communication: perceptions of salience, credibility and legitimacy (SCL).
- We find that messages from a technocratic sender using statistical evidence significantly improved perceptions of SCL and that SCL are a joint set of mediators between knowledge and intention to act.
- Additionally, the roles of SCL depend on characteristics of different knowledge users; importantly, legitimacy matters more for female staff, credibility matters more for frontline providers, and salience and legitimacy both matter for more experienced health workers.
- By focusing on the factors that shape specific knowledge users' perceptions of SCL, those involved in science co-production and dissemination efforts can increase the likelihood of evidence-based public health when direct engagement between researchers and decision-makers is difficult to achieve.

In contrast to the EBP and Science Communication literatures, other scholars working on the knowledge-to-action gap approach this challenge by investigating how changes in knowledge production processes—specifically the degree to which researchers and decision-makers engage in the co-production of knowledge—affect the likelihood of decision-makers trusting and making use of new knowledge (Kristjansson *et al.*, 2009; Pidgeon *et al.*, 2014; Schuttenberg and Guth, 2015; Clark *et al.*, 2016b; Reid *et al.*, 2016; Fischhoff, 2019; Scown *et al.*, 2019). In a similar vein, scholars focused on research uptake in global health have emphasized deliberative dialogues for knowledge translation and exchange (Boyko *et al.*, 2012). The logic behind the focus on engagement and co-production is that in order for any new knowledge to be used in decision-making processes, it first needs to be trusted (Matson *et al.*, 2016). A central theory on this topic, originating in Sustainability Science, is that knowledge users will trust new knowledge when three contextual conditions are present: knowledge users perceive the knowledge to be salient (directly applicable to the decisions faced), credible (likely to be accurate and true) and legitimate (produced by people with the knowledge users' best interests in mind) (Clark and Majone, 1985; Cash *et al.*, 2003; Clark *et al.*, 2006; Dilling and Lemos, 2011).¹ In line with this salience, credibility and legitimacy (SCL) framework, scholars have argued that passive knowledge provision is relatively ineffective (Wibeck, 2014) and that knowledge is best conveyed interactively through personal relationships (Lavis *et al.*, 2003), or via intermediary knowledge brokers and boundary work by convening organizations (Van Kammen *et al.*, 2006; Clark *et al.*, 2006). The SCL framework has important implications for researchers and decision-makers who seek to co-produce usable knowledge to help solve specific problems (Pidgeon *et al.*, 2014). Nonetheless, the emphasis on engagement and co-production in the related literature can sometimes be of limited applicability,

especially in developing countries where many civil servants and practitioners who make and implement public health policies have few opportunities to meet or work directly with researchers. The problem is that for most of these decision-makers, direct engagement with researchers is out of reach. Instead, to promote greater use of scientific knowledge in these contexts, one of the major goals on the global health agenda, knowledge brokers and development organizations have little choice but to rely on messaging and knowledge dissemination campaigns. However, existing approaches provide limited guidance for addressing a common and vexing challenge in the social sector: how to best communicate research findings so that they are received, trusted and put into practice by members of an expansive, heterogeneous and geographically dispersed civil service.

Our study assesses a mid-range approach, informed by the SCL framework but in the absence of opportunities for direct engagement, for understanding the drivers of knowledge uptake and use in a health policy context. Relatively little research, theoretical or empirical, has considered this type of mid-range approach: how researchers, without direct engagement, can most effectively share new findings with large numbers of local-level policymakers, civil servants and practitioners within their established hierarchies and in ways that actually influence their behaviour (Kapadia-Kundu *et al.*, 2012; Pakenham-Walsh, 2012; Kumar *et al.*, 2020). Because of the parsimony of the SCL framework in focusing on the reality that knowledge needs to be trusted to be used, and distinguishing among SCL as joint precursors to trust, it allows one to succinctly bridge the perspectives of the three major literatures related to the knowledge-to-action gap. Specifically, we develop and test three original hypotheses about key factors featured in each of the literatures that may increase the effectiveness of communicating new scientific findings to health workers and administrators in developing countries.

First, we expect that *civil servants perceive new knowledge as more salient, credible and legitimate when the message cites statistical evidence and comes from a technocratic sender*. We investigate the effects of two contrasting ways of presenting scientific evidence (narrative vs statistical) and two different types of senders (technocratic vs. political). An experiment that manipulates messages along these two dimensions will likely generate meaningful variation in the perceptions of civil servants regarding the SCL of the message content. While there is some empirical support for the idea that narratives are often more persuasive than statistics (Nyhan *et al.*, 2014; Braddock and Dillard, 2016), we expect that this effect is dependent on the attributes of the specific target audience (Allen and Preiss, 1997; Garcia-Retamero and Galesic, 2010). In terms of the identity of the sender, previous studies have found that organizations with a technical mandate are often perceived as more legitimate than political organizations, at least among civil servants (Orton *et al.*, 2011; Lupia, 2013). For the civil servants working in the public health sector in Honduras, we expect that they will trust new knowledge more when the messages they receive use statistical evidence and come from a technocratic organization.

Second, we expect *civil servants perceptions of salience, credibility, and legitimacy will jointly shape their intention to act on new knowledge*. We build on scholarship employing the SCL framework to argue that it is not that each

of these three factors is individually influencing knowledge uptake, but that all three are required in order to bridge the knowledge-to-action gap (Cash *et al.*, 2003). In order to trust and use new knowledge, people need to perceive it to have a high degree of SCL. We therefore expect both moderating and mediating relationships to be present in the case of large-scale knowledge dissemination to civil servants. SCL, while individually linked to specific message attributes, can also serve to reinforce and accentuate one another. For example, a message communicated by a highly legitimate source may therefore be perceived as more credible or more salient, and vice versa. Similarly, and in line with existing case study evidence, we also expect that SCL will operate as a joint set of mediators between knowledge and intention to act (Cash *et al.*, 2003; Matson *et al.*, 2016).

Finally, we expect that *the individual characteristics of knowledge users will also influence their perceptions of salience, credibility, and legitimacy, and, in turn, their intention to act*. Recognizing perceptions of SCL as constructed beliefs about the knowledge itself draws our attention to the interplay of message attributes on the one hand and characteristics of individual knowledge users within their social contexts on the other (Hennink and Stephenson, 2005; D'Adamo *et al.*, 2012; Naugle and Hornik, 2014). Clark *et al.* (2016a) emphasize how an individual's perceptions of SCL may be conditional on the individual's perceived relationship with the knowledge itself and the knowledge producer, as informed by institutional context or the type of politics that characterize the issue in question. Accordingly, we analyse how the substantive issue along with individual characteristics like gender, age and job responsibilities influence differential perceptions of SCL, as well as how these perceptions affect intentions to act on the knowledge being communicated.

Study data and methods

We use data from a survey experiment conducted with 261 public sector health workers and administrators in Honduras, who primarily comprise doctors, nurses, social workers and administrators, to test these ideas empirically. Honduras, like most countries in the region, has a dual health system with public and private facilities (PAHO, 2017). The public health system, managed and overseen by the Ministry of Health (MOH), is the major healthcare provider in the country, and this is especially pronounced in rural areas. We focused our survey experiment on new evidence concerning the effectiveness of a particular approach to reducing adolescent pregnancy. We chose this substantive focus because adolescent pregnancy has been and remains a major problem in Honduras, a country having one of the highest rates among countries in Central and South America (Sabonge *et al.*, 2006; Shakya *et al.*, 2020). This is thus a priority area for the MOH and has gained the attention and advocacy of the First Lady of Honduras (MOH, 2012; UNICEF, 2018). Doctors, nurses and health promoters in primary care facilities are the frontline staff most directly involved in providing care, outreach and health education to youth and adolescents (PAHO, 2017). These frontline healthcare professionals have considerable discretion at the local level within the Honduran health system, and some continue to hold beliefs that do not facilitate preventative education relating to family planning to avoid adolescent pregnancy (UNICEF Honduras, 2018, p. 57).

Moreover, there remain uncertainties and differences of opinion about how best to address this complex problem (UNICEF Honduras, 2018; Shakya *et al.*, 2019; 2020). Therefore, the Honduran case is an important and useful one because it is emblematic of the health systems and trends relating to the ongoing challenge of addressing adolescent pregnancy in the region, as well as communicating knowledge to inform policy and practice across a large, diverse and dispersed public health workforce.

In collaboration with the MOH in Honduras, we shared an informational letter regarding the research results of a set of studies on how to prevent teenage pregnancies effectively to health sector civil servants across all 18 Honduran states (Dupas, 2011; Dupas *et al.*, 2018). Potential respondents received a link to the Qualtrics-based survey, entirely in Spanish, which they were invited to complete on a computer, tablet or mobile device. Our full study protocols were reviewed and approved by the Institutional Review Board (IRB) at the authors' institution and all participants provided informed consent. All data discussed in the paper are publicly available as part of replication files posted on the Harvard Dataverse (Zarychta *et al.*, 2021).²

We randomly assigned participants in even proportions to one of four treatment letters that communicate evidence about the same strategy for helping to prevent teenage pregnancy, varying only two aspects of the communication: (1) the sender (technocratic or political) and (2) the presentation of the research findings (statistical or narrative). As discussed above, we selected the relatively controversial topic of prevention strategies for teenage pregnancies because the Honduran MOH has identified reducing teenage pregnancies as a priority for the country and disagreement about strategies to address this problem increases the likelihood of observing meaningful variation among participants' responses to the research findings described in the letters [See Supplementary Information (SI) Section 1.1 for further discussion, including copies of all four versions of the letter in Figure SI-1]. Considering the Honduran context, we used the health representative from the local mayor's office (elected official) as reflecting an information sender from a political organization and role, and the head implementation official from the MOH (bureaucrat) as one reflecting a technocratic organization and role. For more details on the experimental survey design, including descriptive statistics and sample balance, please see SI Section 1.2 (Tables SI-3A–C).

The primary outcome in this paper is the behavioural uptake of the information being communicated to respondents, and we measure this using their reported intention to act. Specifically, after reading their randomly assigned treatment letter, respondents were asked: 'How likely is it that you will use the information presented to make decisions about strategies to reduce adolescent pregnancy in the course of your daily work?' (translated from Spanish). Responses were in the form of a rating on a scale of 0–100 using a sliding indicator in the survey (range: 13–100; mean 83.31; median 90; standard deviation 17.18). While self-reported intention to act is a common measure in survey research, future work that incorporates additional behavioural measures in assessing links between knowledge and action is warranted as a complement to the present study.

We also asked respondents to assess the potential mediators following from the SCL framework: SCL. To counter the

potential for order effects to influence our results (Chaudoin *et al.*, 2021), we randomized the order of the mediators as well as whether they were asked to rate the mediators or intention to act first. For each mediator, respondents were asked to rate their perception of the information, again on a 0–100 scale, as follows (all translated from Spanish). *Salience*: ‘In your view, how salient is the information presented? In other words, do you think that the information in the letter might be useful?’ (range 3–100; mean 79.89; median 86; standard deviation 19.99). *Credibility*: ‘In your view, how credible is the information presented? In other words, do you believe the evidence presented for the strategy suggested in the letter?’ (range 0–100; mean 74.53; median 80; standard deviation 21.45). *Legitimacy*: ‘In your view, how legitimate is the information presented? In other words, do you think that the purpose of [sender]³ in sending the letter is to improve the well-being of adolescents?’ (range 0–100; mean 78.78;

median 85; standard deviation 21.43). Additional descriptive statistics for these measures are presented in Supporting Information (Tables SI-1 and 2 and Figure SI-2).

The substantive conclusions we draw in the paper are based on ordinary least squares regression analysis, using classical standard errors, of the data reported by civil servants participating in our survey experiment. This includes the main effects of the two treatments, sender and presentation of the knowledge, on intention to act, as well as SCL; causal mediation analysis where SCL are modelled as potential pathways explaining the relationship between the treatments and intention to act; and analyses of individual characteristics that may moderate these relationships. We also compared our results against those of a nonparametric model to confirm that they are robust to model specification (see SI Section 2.2 and Figures SI-5 and 6). Additional details for all analyses are presented in the SI.

Table 1. Regression models showing experimental treatment effects (unstandardized coefficients) on salience (S), credibility (C), legitimacy (L) and intention to act (A)

	S	S	S	C	C	C
<i>Sender</i>						
Technocratic (Ref: Political)	3.89 (2.56)			3.55 (2.75)		
<i>Presentation</i>						
Statistical (Ref: Narrative)		4.67* (2.55)			4.28 (2.74)	
<i>Sender × Presentation</i>						
Pol-Stat (Ref: Pol-Narr)			5.28 (3.56)			2.83 (3.80)
Tech-Narr (Ref: Pol-Narr)			4.51 (3.66)			1.96 (3.94)
Tech-Stat (Ref: Pol-Narr)			8.18** (3.53)			7.51** (3.80)
(Intercept)	78.00*** (1.78)	77.50*** (1.82)	75.42*** (2.49)	72.84*** (1.90)	72.35*** (1.96)	71.46*** (2.65)
R ²	0.01	0.01	0.02	0.01	0.01	0.02
Num. obs.	243	243	243	243	243	243
	L	L	L	A	A	A
<i>Sender</i>						
Technocratic (Ref: Political)	7.80*** (2.71)			3.59* (2.14)		
<i>Presentation</i>						
Statistical (Ref: Narrative)		3.93 (2.74)			−1.00 (2.15)	
<i>Sender × Presentation</i>						
Pol-Stat (Ref: Pol-Narr)			4.65 (3.75)			−1.66 (2.98)
Tech-Narr (Ref: Pol-Narr)			8.79** (3.89)			2.97 (3.08)
Tech-Stat (Ref: Pol-Narr)			11.18*** (3.75)			2.56 (3.01)
(Intercept)	75.06*** (1.87)	76.77*** (1.96)	72.78*** (2.62)	81.59*** (1.48)	83.82*** (1.54)	82.42*** (2.11)
R ²	0.03	0.01	0.04	0.01	0.00	0.01
Num. obs.	243	243	243	256	256	256

*** $P < 0.01$,

** $P < 0.05$,

* $P < 0.1$.

Results

Result 1: statistical presentation and technocratic sender improve perceptions of SCL

Table 1 present the results of regression models assessing the effects of the experimental treatments on civil servants' ratings of the perceived SCL of the knowledge being communicated, as well as their intention to act. The technocratic sender engenders more intention to act on the knowledge provided (+3.59 points on the 100-point scale) and that knowledge is perceived as more legitimate (+7.80 pts.) relative to the political sender. Civil servants perceive the knowledge presented with support of statistics as more salient (+4.67 pts.) than the same message supported by a narrative example. And in combination, knowledge that is presented by a technocratic sender in a statistical presentation is perceived to be more salient (+8.18 pts.), credible (+7.51 pts.) and legitimate (+11.18 pts.) relative to knowledge presented by a political sender in narrative presentation. These results are consistent across different model specifications (See SI Tables SI-4–8 and Figure SI-3, for expanded models with controls).

Result 2: SCL interact to jointly mediate the relationship between knowledge and action, although legitimacy may play a slightly different role than the others

We find that greater perceived SCL are all independently associated with increased intention to act on the knowledge provided (See SI Table SI-9 and Figure SI-4). This is in line with our expectations based on prior work with the SCL framework; we also interpret this as support for the validity of our survey-based measures for operationalizing these concepts.

SCL interact with each other to increase knowledge adoption

When testing interactions between the SCL factors as predictors of intention to act, each one displays a significant, positive interaction with each of the others. In other words, SCL generally have a reinforcing relationship with one another for engendering intention to act on the knowledge provided. Specifically, higher credibility and higher legitimacy both accentuate the positive effect of salience in motivating intention to act (**Figure 1**, top panel). Higher salience and higher legitimacy likewise both accentuate the positive effect of credibility in motivating intention to act on the knowledge being communicated (**Figure 1**, middle panel).

The motivating effect of legitimacy on intention to act, however, appears to function somewhat differently. High salience and high credibility are necessary in order to realize the positive effect of legitimacy in motivating intention to act on the knowledge being communicated (**Figure 1**, bottom panel); however, at low salience or low credibility, legitimacy does not display a positive effect. This may in part be explained by gendered differences in the role legitimacy plays, as discussed under Result 3.

The presence of a significant interaction between all three two-way combinations, as well as the implications of the theoretical claims of the SCL framework itself, also suggest that what is ultimately happening is that higher levels of all three factors accentuate each other in the knowledge-to-action relationship. This dynamic is confirmed through a

regression analysis that shows a significant, positive three-way interaction among SCL in shaping intention to act on the knowledge being communicated. (See SI Table SI-10 as well as SI Section 2.2 for an alternative nonparametric model of these relationships.)

Perceptions of SCL jointly mediate a considerable proportion of the relationship between the knowledge being communicated and intention to act

Following the outlines of the SCL framework, we also hypothesized that SCL function as mechanisms 'through' which new knowledge can be translated into action. To test this possibility, we employ causal mediation analysis to distinguish joint correlation from mediation pathways (Tingley *et al.*, 2014). We assessed each pathway (SCL) for mediated effects of the treatments (sender and presentation). However, the general picture given by the SCL framework is not that each mediator operates independently, but rather that they work in concert to provide the channel through which new knowledge is translated into action. We therefore also conducted causal mediation analysis using a joint mediator variable scaled to reflect this interaction among the three variables (VanderWeele and Vansteelandt, 2014).

We find that both the statistical presentation and the technocratic sender positively influence intention to act 'by means of' their influence on perceptions of SCL (**Table 2**). This is most pronounced for the sender of the information (alone and when interacted with presentation format) where about 75% of the relationship between the experimental treatments and intention to act flows through perceptions of SCL (the mediated effect size is +2.900 pts., out of +3.785 pts. in total effect). Separate tests of the mediators individually suggest that legitimacy is the predominant causal channel for this relationship.

The other finding of note here is that the mediated and direct effects of message presentation format point in opposite directions. The main regression analysis of these experimental treatments found that varying the presentation of the knowledge alone had no significant association with intention to act, which is inconsistent with some prior views that narratives are generally more effective motivators (Nyhan *et al.*, 2014; Braddock and Dillard, 2016). This mediation analysis provides some clarity: the statistical message is indeed associated with lower intention to act than is the narrative (seen in the direct effect of -3.972 pts.). However, the statistical message is also associated with a positive overall effect on SCL, in a way that increases intention to act (seen in the mediated effect of +2.418 pts.). This suggests that while narrative communication may indeed have some motivating direct effect, the relationship is nuanced and a positive 'net' effect should not necessarily be presumed.

Result 3: knowledge users may respond to SCL in different ways depending on their gender, age and professional roles

We expect to observe individual variation in the degree to which people 'perceive' any given information as possessing salience, credibility or legitimacy. In this context, such variation would appear as an interaction effect between the experimental treatment and the particular demographic characteristic. Additionally, while SCL may all generally play a

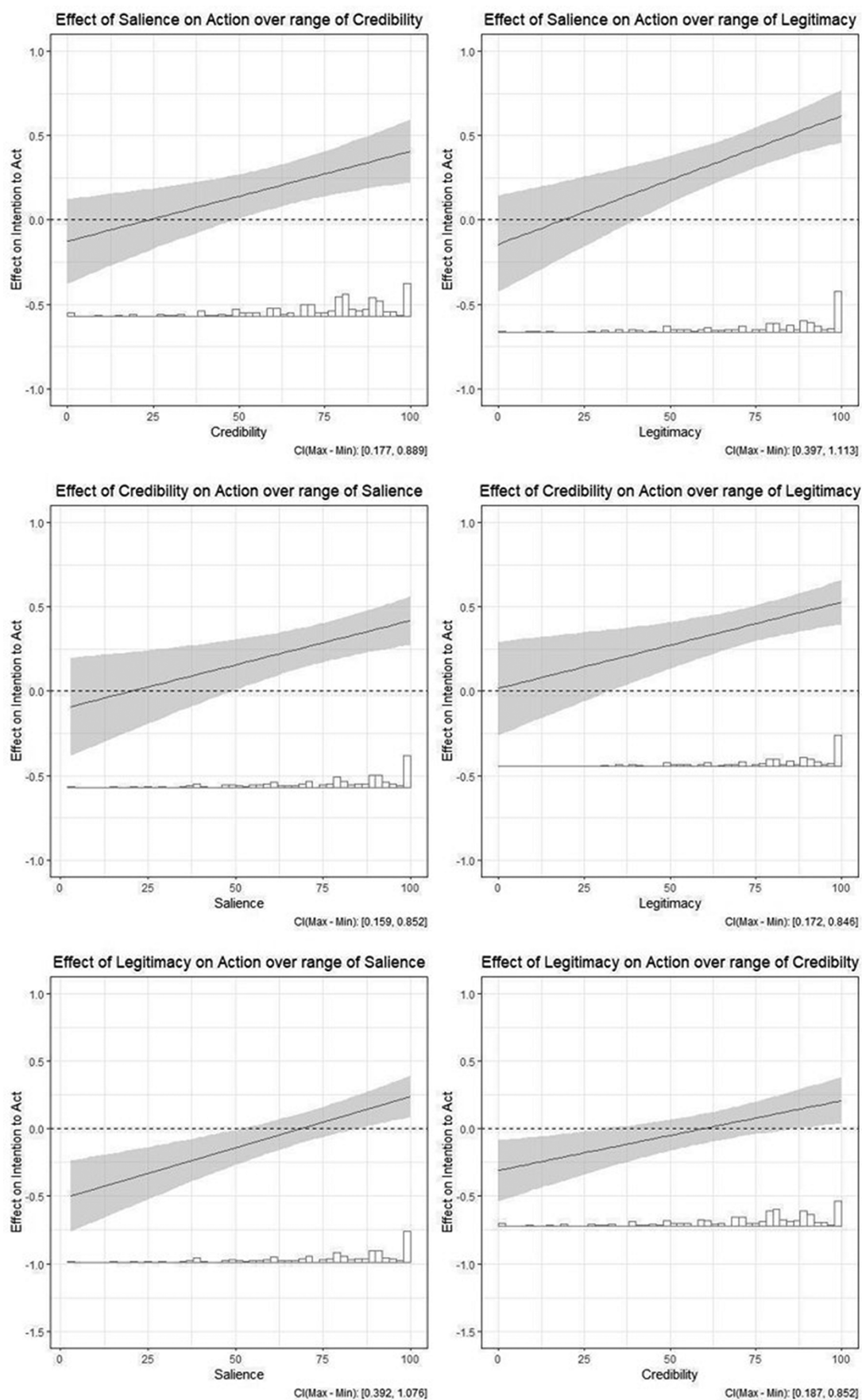


Figure 1. Higher credibility and higher legitimacy both accentuate the positive effect of salience in motivating intention to act on the knowledge being communicated (top panel), and a similar relationship holds for the positive effect of credibility in terms of salience and legitimacy (middle panel); in contrast, high salience and high credibility are necessary in order to realize the positive effect of legitimacy in motivating intention to act (bottom panel) (Figures generated using full models from Table SI-10)

Table 2. Mediation analysis showing treatment effects on intention to act through a combined SCL pathway

Treatment	Mediated effect via SCL	Direct effect	Total effect	Proportion mediated	Num. obs.
Technocratic sender	2.900** <i>P</i> = 0.022	0.885 <i>P</i> = 0.662	3.785* <i>P</i> = 0.074	75.4%	234
Statistical presentation	2.418** <i>P</i> = 0.044	-3.972** <i>P</i> = 0.036	-1.553 <i>P</i> = 0.474	37.8%	234
Tech-Narr	0.597 <i>P</i> = 0.670	2.324 <i>P</i> = 0.320	2.921 <i>P</i> = 0.270	24.5%	234
Tech-Stat.	3.346** <i>P</i> = 0.014	-0.894 <i>P</i> = 0.706	2.452 <i>P</i> = 0.380	78.9%	234
Pol-Narr.	-3.622** <i>P</i> = 0.012	2.881 <i>P</i> = 0.164	-0.741 <i>P</i> = 0.746	55.7%	234
Pol-Stat.	-0.208 <i>P</i> = 0.894	-4.202** <i>P</i> = 0.044	-4.409* <i>P</i> = 0.082	5.9%	234

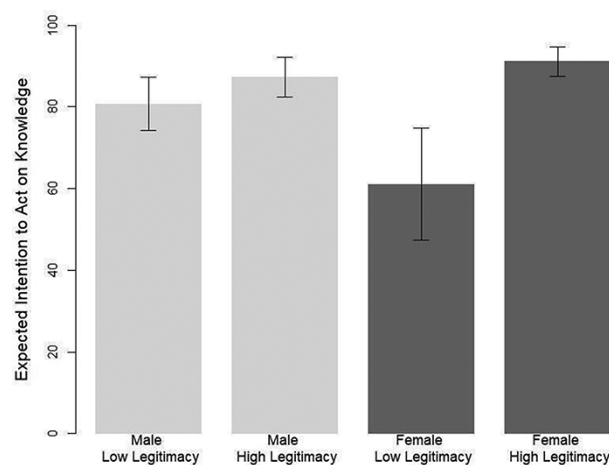
****P* < 0.01,***P* < 0.05,**P* < 0.1.

role in translating knowledge into action, it does not necessarily follow that they play the same role, or are of the same importance, for all actors. If this holds, we would expect to see it as an interaction effect between the demographic characteristic and salience, credibility or legitimacy (namely, effect size or relative importance of these moderators would vary for different civil servants). Both of these theoretical expectations are supported by our analytical results.

From the demographic information available to us, we identified several reasonable candidate characteristics prominent in the literature on representative bureaucracy (Meier and Bohte, 2001; May and Winter, 2009; Vinopal, 2020): age—older civil servants might interact with information differently than younger ones; gender—women might respond differently than men, particularly given the subject matter of the knowledge intervention; and professional role—in particular, whether the respondent is a frontline health worker or in a managerial role. We also considered respondents' education level, but did not see clear differences after accounting for closely related correlates such as age and job position.⁴

We find that gender plays an important role in influencing perceived legitimacy. Women generally perceive the local political authority ('the health representative from the mayor's office') as a less legitimate sender of information relative to the MOH (effect size of technocratic sender is +15.28 pts. higher among women than men, *P* = 0.0085; see SI Table SI-11A). In this context, the results mean that women tend to question whether this particular sender is communicating the information with the best interests of women, and particularly adolescents, in mind. Men, however, see no difference in legitimacy based on the sender, and women rate information from the MOH the same as men do.

But the differences are not about perception only; the relationship between legitimacy and intention to act also varies by gender. Among women, the perceived legitimacy of the information provided is considerably more important in facilitating intention to act on that knowledge (the effect size of legitimacy is 0.24 pts. higher for women than for men, which is 2.7 times the effect for men; *P* = 0.037). As women also display a lower baseline intention to act, another way to describe this finding is that women are somewhat less likely to act on information provided in this domain irrespective of the sender or type of evidence presented, but for this sample of public

**Figure 2.** Legitimacy is especially important among female civil servants in motivating intention to act on knowledge provided (Figure based on the full model from Table SI-11B)

officials, legitimacy plays a more important role in motivating action among women relative to men (Figure 2).

Knowledge users' professional role in the workplace and their age also provide examples of audience characteristics that can alter how perceptions of SCL affect knowledge uptake. In terms of role, we divided respondents into two categories. 'Frontline health workers' are healthcare professionals directly engaged in community healthcare delivery, while 'Managers' play an administrative role that is less likely to involve direct interaction with community members, including adolescents. Frontline health workers, we find, were somewhat less likely than managers to express an intention to act (-20.82 points in the credibility interaction model), and perceived credibility appears to be more important for them (the effect size of credibility is 0.22 pts. higher among frontline health workers than managers; see SI Table SI-12). In other words, those in managerial roles were more willing to give something a try, while the frontline health workers wanted more confidence that it would work before expressing an intention to act on it.

Finally, we examined whether age influences the way respondents act on information. We find (see SI Tables SI-13A

and 13B) that older respondents express lower intention to act on the information in general, no matter how it is presented. At the same time, older respondents see the technocratic-narrative version as more credible overall (+1.01 pts. more credible per year of respondent's age). Salience and legitimacy also appear to be more important for motivating action among older respondents than younger ones (effect size of each increases by 0.01 pts. per year of age). Essentially, while older public officials in our sample are initially less likely to act on the information, that difference by age disappears when the information is seen as highly salient or legitimate.

Taken together, one interpretation of these findings would be that the individual attributes that matter most have to do with the 'perceived costs' of knowledge uptake, which is in line with Miller and Prentice's (2013) notions of psychological taxes and subsidies among approaches to behaviour change. More generally, it is well established that decision-makers across different sectors, health among them, are boundedly rational and rely on shortcuts and heuristics when making decisions (Thaler and Sunstein, 2008; Halpern, 2015; Battaglio *et al.*, 2019). This includes defaulting to status quo approaches based on existing knowledge and beliefs, so any strategy for behaviour change will need to consider the alignment of economic and psychological costs for the individuals affected (Miller and Prentice, 2013). Shared characteristics of key groups could be one useful way to begin identifying and addressing these barriers, as factors like gender, job type and age have been shown to be important for understanding and supporting change in organizations (Szamosi and Duxbury, 2002).

In this case, e.g. all three of the groups considered may face higher costs to adopting and acting on new research findings based on their attributes and positions. For women, this effect would be linked to the knowledge intervention's subject matter: prevention of adolescent pregnancy. As they have direct experience having been part of the group (adolescent females) most directly affected, they might be better informed or more discerning of the evidence about what is likely to work, as well as—given the controversial cultural and political dimensions of the subject—more sceptical of the motives of the senders of the message, leading both to lower overall intention to act and a greater emphasis on legitimacy. Likewise, for the frontline health workers, action might involve relatively higher perceived costs associated with changing their daily work routines, as compared with managers who would merely supervise such routine changes. In a similar fashion, older respondents might be more likely to display forms of behavioural inertia linked to longer experience and stronger commitment to existing strategies. While the analysis here has identified important differences in SCL and knowledge uptake for these key groups and suggested a set of cost-based explanations for those differences, additional research is warranted to more fully assess these explanations.

Discussion

The findings of this study are relevant to debates about how to create stronger links between scientific knowledge and policy action when direct engagement is out of reach, either because of structural factors like in the case of a large and geographically dispersed civil service or situational factors such as physical distancing guidelines during a global health pandemic.

These debates have taken place, largely in parallel, within three separate literatures focused on the knowledge-to-action gap: Evidence-Based Practice and Policy, Science Communication, and Knowledge Co-production. We developed three original hypotheses drawing on theoretical ideas from previous studies in all three literatures, and our analytical results show how the ideas from these literatures can inform each other. Most generally, our findings demonstrate that when co-production is too costly, there are ways to structure the communication of research findings so that the chances for uptake improve significantly by paying attention to who the audience is, how research findings are presented and by whom as related to three important contextual features: perceptions of salience, credibility, and legitimacy (SCL). It is important to recognize, however, that research on co-production of knowledge suggests that there can be circumstances when co-production may not be effective, such as when stakeholders are weakly motivated to participate in such a process (Neshkova and Guo, 2012), or when the needed knowledge is highly technical combined with reasonably high levels of certainty and relatively low stakes (Funtowicz and Ravetz, 1993).

For the broader understanding of science communication in the context of public health, we demonstrate that the SCL framework is generalizable enough to account for knowledge uptake in contexts quite different from those for which it was originally developed. SCL are three important contextual features that mediate knowledge uptake in the arena of public health as well as sustainability writ-large; in directed dissemination of research findings as well as the ongoing co-production of knowledge; and with bureaucratic or professional knowledge users as well as the general public. Our findings also raise some questions about the role of narratives, suggesting that, once accounting for other aspects of SCL, there is a need to develop a more nuanced view of the conditions under which and audiences for whom narratives may be the most effective way of motivating knowledge uptake and associated action.

For the SCL framework itself, our findings support the validity of its general theoretical contributions. We find that SCL play a mediating role between knowledge and intention to act. We also find that these mediators are mutually interactive, such that the effect of each one of these factors is at least partly conditional on the presence of the other two. In the process, our study provides other SCL researchers with plausible ways to operationalize measures of SCL for future empirical work.

Furthermore, we tested whether the framework's application depends in practice on existing characteristics of different knowledge users, which public communication research suggests might shape receptivity to new knowledge. Previous work developing the SCL framework suggested the potential that context is important in general (Clark *et al.*, 2016b). This study improves our understanding of *what kinds* of contextual variations matter and *how* they matter, in this case for public health officials in Honduras. By considering how different individuals come to trust knowledge as a consequence of their perceptions of SCL, public health officials will be able to design more effective communications that are both context-sensitive and audience-specific.

We found, notably, that legitimacy matters more for female health workers and administrators, credibility matters

more for frontline health workers, and salience and legitimacy both matter for more experienced policy actors. We suggested that these relationships may be linked to the perceived costs of behavioural change in the relevant domain. This cost-based hypothesis would benefit from further investigation in future studies, as would other potential causal factors related to when and why knowledge users' characteristics matter for linking knowledge with action. While our findings confirm the general proposition that such characteristics can matter for trusting and intending to act on new research findings, there is opportunity here for further investigation to improve our understanding of these effects.

This also points to the potential for strengthening public health communication further with tailored messaging that perhaps recognizes and addresses additional perceived costs among certain groups. This approach could take advantage of framing effects, a phenomenon whereby the same information presented differently can lead to differences in related opinions (Chong and Druckman, 2007). There is reason to believe that framing is most effective when tailored to the specific individual or context (Andrews *et al.*, 2013; Grillos *et al.*, 2019), and it may thus also be most effective when tailored to specific identity groups. But the framing literature has not directly examined effects on SCL as crucial mediators of successful uptake. Another plausible approach to overcoming group-specific effects is to identify messengers who clearly represent or belong to the target group. These ideas are promising but conjectural and require further evaluation. Future, solution-oriented research could, for example, vary the gender of the sender in addition to their role, or add language that recognizes special challenges faced by women, to see whether information presented in this way could mitigate the differential effects we observed in the case of information about a strategy to address adolescent pregnancy. Furthermore, taking account of ideological factors or political affiliation, something we were not able to include in this study, is another important area for additional research.

Additional research along these lines will, we hope, prove fruitful in developing techniques that allow researchers, science communicators and public organizations to harness the SCL framework within particular contexts in ways that more effectively encourage greater use of research in policymaking and practical applications, even where structural and situational factors prevent the ideals of engagement and co-production from being fully realized.

Conclusion

Co-production of knowledge has been a prominent approach for addressing the knowledge-to-action gap and facilitating greater uptake of evidence in public health policy and implementation. For most public sector health workers in low- and middle-income countries, however, practical constraints significantly limit opportunities for the types of direct engagement that define co-production. Nonetheless, relatively little research has considered ways the co-production approach can inform strategies for effectively sharing new knowledge so that it is received, trusted and put into practice by members of an expansive, heterogeneous and geographically dispersed health service.

Bridging evidence-based practice, science communication and knowledge co-production perspectives, our study introduces a more nuanced view of how knowledge users come to trust and adopt new evidence when implementing public health policies based on perceptions of salience, credibility, and legitimacy (SCL). We find that messages from a technocratic sender using statistical evidence significantly improved perceptions of SCL, which goes against some conventional wisdom that descriptive narratives are more effective for communicating new knowledge. Additionally, we find that SCL operate as a joint set of mediators between knowledge and intention to act. Finally, the roles of SCL depend on characteristics of different knowledge users; importantly, legitimacy matters more for female staff, credibility matters more for frontline health workers, and salience and legitimacy both matter for more experienced staff members.

More effective linking of scientific knowledge with policy action is imperative for advancing global health and social development goals. Towards those ends, our work is relevant to understanding how and why health workers come to trust and use new knowledge in their day-to-day work of serving the public interest. Ultimately, understanding what motivates trust in science is critical to understanding policy uptake and behavioural change, as has become abundantly clear during the coronavirus disease 2019 pandemic around the world. The findings of our research can support individuals involved in science co-production, exchange, and dissemination efforts increase the likelihood of evidence-based public health when direct engagement between researchers and decision-makers is difficult to achieve.

Supplementary data

Supplementary data are available at *Health Policy and Planning* online.

Data availability statement

All data discussed in the paper are publicly available as part of replication files posted on the Harvard Dataverse (Zarychta *et al.*, 2021). Data and replication files are available here: <https://doi.org/10.7910/DVN/RPXGM1>.

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Conflict of interest statement. The authors declare that they have no conflict of interest.

Notes

1. Legitimacy, in this sense, may be driven by a range of different factors, including perceived warmth or competence (Fiske *et al.*, 2007). While the specific drivers of perceptions of SCL are important in their own right, our main focus in this study is on the relationship between those perceptions of SCL and knowledge uptake.
2. Data and replication files are available here: <https://doi.org/10.7910/DVN/RPXM1>.
3. The sender varied by treatment group as described previously; depending on the version of the letter the respondent received, the appropriate name of the sender was inserted into this question.
4. Respondents' prior attitudes towards adolescent pregnancy and associated strategies are another potentially relevant characteristic to consider as interactions here. Unfortunately, the political context in which the survey was conducted precluded us from including these questions. We recognize this is a limitation of this study and an area for additional research.

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