



## A survey instrument for measuring vaccine acceptance

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### ABSTRACT

Accurately measuring vaccine acceptance is important, especially under current conditions in which misinformation may increase public anxiety about vaccines and politicize vaccination policies. We integrated substantive knowledge, conceptualization and measurement expertise, and survey design principles to develop an instrument for measuring vaccine acceptance across the general public. Given this broad goal, we expect our novel instrument will complement, rather than replace, existing instruments designed specifically to measure parents' vaccine hesitancy. Our instrument measures five key facets of vaccine acceptance: (1) perceived safety of vaccines; (2) perceived effectiveness and necessity of vaccines; (3) acceptance of the selection and scheduling of vaccines; (4) positive values and affect toward vaccines; and (5) perceived legitimacy of authorities to require vaccinations. We report results of analyses demonstrating the reliability and validity of this instrument. High Cronbach's alpha values for five sub-scales and for the full scale indicate the instrument's reliability, and the consistent performance of expected predictors (i.e., trust in biologists, conspiratorial ideation, and political ideology) demonstrates the instrument's construct validity. Further, scientific reasoning increases vaccine acceptance among liberals but decreases vaccine acceptance among conservatives, which is consistent with motivated cognition. Also, trust in biologists has a stronger positive effect on vaccine acceptance among conservatives than among liberals, signaling a potentially promising means to reduce political polarization on vaccines and increase vaccine acceptance across the general public. We end by identifying key ways that public health researchers, science studies scholars, and health practitioners may employ the full (or short) version of our vaccine acceptance instrument.

### 1. Introduction

In the past decade, researchers have focused attention on skeptical attitudes some people have about the safety and efficacy of vaccines and on the hesitancy with which some people respond to vaccination schedules (Largent, 2012; Larson et al., 2014; Navin, 2016). While most research on vaccine hesitancy focuses on parents (Gust et al., 2008; Nyhan et al., 2014), medical professionals sometimes also manifest these tendencies (Suryadevara et al., 2015). Research on vaccine hesitancy also focuses on the prevalence of anti-science attitudes (Lewandowsky et al., 2013) and on public distrust of scientists (Hamilton et al., 2015). Since protection from disease outbreaks often requires very high rates of vaccine compliance, decreased rates of vaccine acceptance among parents pose significant public health risks, as do heightened anti-vaccination attitudes across the public more generally. Some states, most notably California (Legiscan, 2015), have resisted vaccine hesitancy by making it more difficult to enroll under-

vaccinated children in school or daycare.

Vaccination policy generally has been a bipartisan affair, and vaccine hesitancy correlates only modestly with Republican Party identification (Hamilton et al., 2015). However, California's Senate Bill 277 passed with a strong party-line vote: 22 of 23 Democrats for; 12 of 14 Republicans against (Legiscan, 2015). More indicative of the potential politicization of vaccines (and vaccination policy) is that three of the leading candidates for the 2016 Republican nomination for US President—Donald Trump, Rand Paul, and Ben Carson—called for abolishing the school and daycare vaccine mandates that California's law made it more difficult for parents in that state to escape (Tavernise and Louis, 2015). Further, President Trump provides powerful platforms for anti-vaccination activists (Garrett, 2017) to promote their views (Kata, 2012), and he personally repeats these views when claiming there is a link between vaccines and autism (Kopplin, 2016). These actions encourage forms of motivated cognition that may increase vaccine hesitancy among parents and decrease vaccine acceptance within the

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broader public (Kahan, 2013).

In the context of heightened public anxiety about vaccines and the potential politicization of vaccination policies, we integrated substantive knowledge, conceptualization and measurement expertise, and survey design principles to develop an instrument for measuring vaccine acceptance across the general public. Section 2 briefly describes the development of this new vaccine acceptance instrument. Sections 3 and 4, respectively, present the methods and results of a recent study providing evidence of the reliability and validity of this instrument for measuring vaccine acceptance in the general public. Section 5 offers guidance and suggestions for implementing this new instrument in future research.

Our paper makes three key contributions to the interdisciplinary scholarship on vaccination views, behaviors, and policies. First, we confirm the reliability and validity of a new vaccine acceptance instrument, which overcomes some of the conceptual and measurement limitations of existing instruments designed primarily for administration to parents. Second, we also provide a short version of the instrument that scholars and practitioners may employ in surveys where space is very limited. Third, we replicate key results from recent studies on public views of vaccines, especially the influence of politically motivated cognition on vaccine acceptance.

## 2. Developing the vaccine acceptance instrument

### 2.1. Existing questionnaires for measuring vaccine hesitancy

Our general goal is to measure vaccine acceptance across the general public, and not only among parents who make vaccination decisions in their families. A broader approach facilitates improved understanding of support for vaccination policies and the effectiveness of health communication efforts. Our commitment to this broader approach motivated our creation of a new instrument to complement the three existing tools that biomedical scholars and health practitioners have designed to measure parents' vaccine hesitancy. Opel et al. (2011, 2011) made the 18-item Parent Attitudes about Childhood Vaccines Survey (PACV) primarily for assessing vaccine hesitant parents in clinical settings. Gilkey et al. (2014, 2016) constructed their 8-item Vaccine Confidence Scale (VCS) using items from an existing centers for Disease Control and Prevention survey. Larson et al. (2015) identified a set of 10 Likert-scale items for measuring vaccine hesitancy across many national contexts. As useful as these tools have been, key measurement and survey design limitations constrain their efficacy for use in surveys of the general public. We briefly identify these two types of limitations before discussing how our new instrument addresses them.

Like most theoretically salient and politically contentious concepts (especially those that represent human beliefs or attitudes), the conceptual domain of “vaccine hesitancy” (or “vaccine acceptance”) likely is complex and multidimensional. Unfortunately, one existing instrument is inattentive to the conceptual dimensionality of “vaccine hesitancy” (Larson et al., 2015). Another identifies two general dimensions (perceived benefits and perceived harms), which does little to deepen our understanding of the diversity of concerns that are associated with vaccine hesitancy (e.g., perceived safety, selection, efficacy, and necessity) (Gilkey et al., 2014). Two instruments include a “trust” dimension, which we argue is more appropriate to consider as a unique theoretical concept that may (or may not) relate to vaccine hesitancy (Gilkey et al., 2014; Opel et al., 2011, 2011). The two instruments that do attend to dimensionality nevertheless use different numbers of items to capture the dimensions: eight items (beliefs about vaccine safety and efficacy) and one item (attitude about vaccine mandates and exemptions) in the PACV (Opel et al., 2011, 2011); and four items (benefits) and two items (harms) in the VCS (Gilkey et al., 2014, 2016). Such wide variation in the number of items used to measure these dimensions is less than optimal and raises questions about the reliability and validity of these instruments. Further, the PACV has two additional

conceptualization and operationalization limitations. First, it combines both cognitive (e.g., belief and attitudinal) and self-reported behavioral (and behavioral intention) items, thus complicating its use as a cognitive instrument. Second, it uses three different response formats (dichotomous yes/no; a 5-point Likert scale; and an 11-point scale with only the two endpoints labeled), which requires significant recoding of the different types of items or standardization of them prior to scale construction.

Not only do these existing vaccine hesitancy instruments pay limited, inconsistent attention to conceptual dimensionality, they also contain four features that are out of step with key survey design principles (Dillman et al., 2014). These features may introduce bias by increasing measurement error and/or item nonresponse error:

- unbalanced question stems (e.g., asking “Do you agree with ...” when the response categories range from “strongly disagree” to “strongly agree”) (Larson et al., 2015; Opel et al., 2011, 2011);
- inconsistent consideration of opinion valence (e.g., whether “trust” is measured as univalent from “do not trust at all” to “completely trust” or as bivalent from “completely distrust” to “completely trust”) (Opel et al., 2011, 2011);
- few reverse-worded items to reduce the acquiescence effect (or the tendency for respondents to agree with statements) (Gilkey et al., 2014; Larson et al., 2015); and
- unlabeled response categories, which increase the likelihood that respondents differently interpret the meaning of adjacent response categories (Gilkey et al., 2014).

### 2.2. The new vaccine acceptance instrument

To create our vaccine acceptance instrument (see Table 1), we integrated insights from public health, humanities, and social science scholarship (Gust et al., 2008; Hamilton et al., 2015; Largent, 2012; Larson et al., 2014; Lewandowsky et al., 2013; Navin, 2016) to capture the full conceptual domain of “vaccine acceptance.” After reviewing the relevant literatures and existing instruments used to measure vaccine hesitancy, we employed our expertise in an iterative fashion to identify the most important facets of vaccine acceptance or hesitancy. On the basis of our review of existing instruments, and in tandem with a broader review of the history, philosophy, and social science scholarship on vaccinations and health-related issues, we produced a set of Likert-scale items that tap five theoretical and empirical dimensions of vaccine acceptance. Each facet of our instrument captures the positive claims of medical and public health professionals in addition to concerns expressed by vaccine hesitant parents and other vaccine skeptics. We measured each dimension with its own 4-item sub-scale of forward-worded and reverse-worded statements.

The first two sub-scales, “perceived safety of vaccines” (items 1–4 in Table 1) and “perceived effectiveness and necessity of vaccines” (items 5–8), address what are perhaps the most prominent issues of vaccine safety and efficacy. The third sub-scale, “acceptance of the selection and scheduling of vaccines” (items 9–12), focuses on claims and concerns about the amount and scheduling of vaccines, which may induce different motivations and policy implications. The fourth sub-scale, “positive values and affect toward vaccines” (items 13–16), attends to values-based emotions that may incline people toward vaccine acceptance or hesitancy somewhat independent from specific concerns about safety, efficacy, and scheduling. The fifth sub-scale, “perceived legitimacy of authorities to require vaccinations” (items 17–20) taps beliefs relevant to public policy about immunization, which recently has become an area of political disagreement.

In addition to focusing closely on the conceptual dimensionality of vaccine acceptance, we also employed leading survey design principles to reduce measurement error and item nonresponse error (Dillman et al., 2014). We used a balanced question stem (“Please indicate whether you disagree or agree with ...”) to capture the full range of

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