Predicting intention to receive a seasonal influenza vaccination using Protection Motivation Theory

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Abstract

Rationale: Seasonal influenza vaccination rates are below the recommended targets, contributing to significant preventable harms. Protection Motivation Theory (PMT), a widely applied model of motivation to respond to threats, may provide some insights into strategies to increase the rate of vaccine uptake. However, previous research has omitted some of the proposed predictors of intention when applying this model to vaccination.

Objective: The aim of the study is to assess the utility of the PMT in predicting intention to obtain the seasonal influenza vaccine. This study will be the first to examine the role of all six PMT constructs in predicting intention to receive the seasonal influenza vaccine.

Method: A cross-sectional study of 547 US residents was conducted using Amazon MTurk.

Results: All constructs show significant bivariate correlations in the direction expected from the prior literature. However, examination of the theory within a linear regression model found that perceived costs of vaccinating (response costs) did not uniquely account for variance in intention. All other components, perceived severity of and susceptibility to influenza, the perceived benefits of not vaccinating (maladaptive response rewards), the self-efficacy to vaccinate, and the perceived efficacy of vaccinating in preventing influenza (response efficacy) were unique predictors of intention. Overall, the PMT accounted for 62% of the variance in intention to vaccinate.

Conclusions: The study is the first to investigate influenza vaccination using all six theorised predictors of intention from the PMT. The findings highlight the importance of the simultaneous inclusion of all components of the model in assessing their potential utility as targets for

intervention. Importantly, the results identify under-utilised constructs in the promotion of vaccine uptake, such as maladaptive response rewards, which should be considered targets for future intervention.

Keywords: Protection Motivation Theory, Immunization, Seasonal Influenza, United States of America, Vaccination

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Seasonal influenza is a major contributor to ill health and lost productivity, with an estimated annual direct cost to healthcare of $3.5 billion in the United States alone (Yan, Weycker, & Sokolowski, 2017), and is a significant contributor to early mortality particularly among the elderly (Thompson, Comanor, & Shay, 2006). Vaccination is an effective strategy for the minimisation of influenza related harms, with 2016-17 vaccination reducing the risk of medically attended acute respiratory illness by an estimated 48% (Flannery et al., 2017), and well-matched vaccination estimated to reduce all-cause mortality in nursing home residents by 2% (Pop-Vicas, Rahman, Gozalo, Gravenstein, & Mor, 2015). The Centers for Disease Control and Prevention (CDC) recommends yearly seasonal influenza vaccination for all persons aged ≥ 6 months who do not have contraindications (Grohskopf, 2018). Despite this, vaccination uptake remains low, with an annual average coverage in the United States of 46.8% (CDC, 2018). This is well below the Healthy People 2020 target for 70% uptake of the seasonal influenza vaccination among non-institutionalised adults (U.S. Department of Health and Human Services Office of Disease Prevention and Health Promotion, 2013).

The delay or outright refusal of vaccination despite its availability, referred to as vaccine hesitancy (MacDonald & others, 2015), contributes to reduced coverage rate (Ernst & Jacobs, 2012) and as such should be a focus of interventions. Vaccine hesitancy is suggested to be driven by three processes, (lack of) confidence in vaccination and the systems and processes that promote and administer them, complacency regarding the risks of vaccine preventable disease, and convenience of vaccination services to the individual (MacDonald & others, 2015). While

much of the vaccine hesitancy literature has focussed on childhood vaccinations such as MMR, pertussis and diphtheria, there is some evidence that these same concerns about vaccinations do have a negative impact on influenza vaccination uptake in children (Hofstetter et al., 2018), and healthcare workers (Dini et al., 2018).

A recent review of vaccine hesitancy in the context of influenza vaccination has particularly called for increased consideration of the role of psychological variables in understanding individual differences in vaccination uptake (Schmid, Rauber, Betsch, Lidolt, & Denker, 2017). The review also noted that while psychological variables are frequently examined in the context of vaccination, such research is rarely based on any formal psychological theory of health behaviour or health behaviour change. This presents a challenge to the development of effective interventions to increase uptake since theories of behaviour and behaviour change provide the basis of best-practice intervention design (Rothman, 2004). Indeed, meta-analytic work indicates that theory-based interventions are more effective at increasing vaccination uptake than interventions not based on explicit theory (Stone et al., 2002).

While theory-based interventions appear promising within the context of vaccination, primary research is lacking to investigate the applicability of some common theories of health behaviour and health behaviour change to uptake of seasonal influenza vaccination. One such theory is Protection Motivation Theory (PMT, Maddux & Rogers, 1983) which is a social cognition theory developed to understand how people respond to health threats (such as seasonal influenza). According to PMT, propensity to engage in protective behaviours (such as obtaining a vaccination) in response to a threat is determined by the beliefs that people have about engaging in (or not engaging in) the desired protective behaviour and about the threatening event itself. According to the theory, intention is the most proximal predictor of behaviour. In turn, intention

is determined by two parallel process, threat appraisal and coping appraisal. Threat appraisal is determined by an individual's beliefs about the seriousness of the negative consequences of the health threat (severity), vulnerability to the negative consequences of the threatened event (susceptibility) and benefits of the performance of the maladaptive behaviour (maladaptive response rewards). Coping appraisal is determined by an individual's beliefs about the effectiveness of the recommended preventative behaviour in averting the occurrence of or the negative consequences of the threatened event (response efficacy), confidence in one's ability to successfully perform the preventative behaviour (self-efficacy), and barriers to performance of the preventative behaviour (response costs). According to PMT, individuals are most motivated to engage in protective behaviour when encountered by a threatening event when they believe that lack of action poses a threat to themselves (high threat appraisal) and that performing the preventative behaviour can ameliorate that threat (high coping appraisal).

A systematic review of predictors of uptake of vaccination for pandemic influenza concluded that elements of both threat appraisal and coping appraisal are associated with vaccination uptake (Bish, Yardley, Nicoll, & Michie, 2011). The utility of PMT in explaining vaccination is further reflected in the substantial alignment between the PMT and the standard model of vaccine hesitancy, with confidence and convenience reflecting coping appraisal, and complacency reflecting threat appraisal. Despite this, few studies have applied PMT to seasonal influenza uptake. Studies that specifically investigate the PMT in the context of seasonal influenza vaccination are necessary given that the relative importance of different constructs are likely to be behaviour-dependent. For example, response efficacy may be particularly important to target in the context of seasonal influenza since the influenza vaccine is much less effective than other vaccines that are commonly included on vaccination schedules.

Studies have demonstrated a relationship between two key components of risk appraisal, perceived susceptibility and perceived severity, and seasonal influenza vaccination uptake (Falato, Ricciardi, & Franco, 2011; Freimuth et al., 2017; Quinn, Jamison, Freimuth, An, & Hancock, 2017; Weinstein et al., 2007). However, the role of maladaptive response rewards is only rarely considered in PMT studies (Floyd, Prentice-Dunn, & Rogers, 2000) and has not been investigated in the context of seasonal influenza. The coping appraisal constructs of response costs, response efficacy, and self-efficacy have all been associated with intention to receive the seasonal influenza vaccine (Ernsting, Lippke, Schwarzer, & Schneider, 2011; Falato et al., 2011; Freimuth et al., 2017; Weinstein et al., 2007). Importantly, no study has examined all three coping appraisal constructs from the PMT while also investigating threat appraisal constructs. Instead, studies that have used the theory in the context of seasonal influenza have tended to include only a subset of constructs from the theory. This study will be the first to examine the role of all six PMT constructs in predicting intention to receive the seasonal influenza vaccine.

Hypotheses

We hypothesise that intention to obtain a seasonal influenza vaccination will have significant *positive* relationships with

- H1: perceived severity of influenza
- H2: perceived susceptibility to influenza
- H3: perceived efficacy of the vaccine (response efficacy)
- H4: confidence in one's ability to obtain a vaccination (self-efficacy)

We hypothesise that intention to obtain a seasonal influenza vaccination will have significant *negative* relationships with

- H5: maladaptive response rewards
- H6: perceived response costs

Methods

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Participants

The sample described in this paper represents the control group of a larger experimental study. Participants were recruited to a "study investigating people's responses to messages about scientific issues" via Amazon MTurk in exchange for $1.10USD in Amazon credit. In order to be eligible, participants needed to be 18 years or older and US residents. No worker qualifications or prescreens were applied via Amazon MTurk. On average, participants took 5.6 minutes to complete the survey. Sample size was determined *a priori* as part of the larger study, the preregistration of that study can be found at: https://osf.io/nhcfv/. After removal of duplicate and incomplete submissions 547 participants were included in this study.

The demographic characteristics of the sample are shown in Table 1.

Materials

Procedure. Participants completed an online questionnaire that included all measures and the experimental manipulation for the broader study via the online survey platform Qualtrics.

The first component of the questionnaire included measures of demographic variables. The participants in this study then proceeded directly to the PMT questionnaire (n.b. some

participants in the larger study were randomised to receive an experimental manipulation prior to completing the questionnaire but data from these participants is not reported here). The order of items within the PMT questionnaire was randomised to reduce order effects. At the conclusion of the study participants were invited to provide feedback on the survey via a free-text response box. The survey did not include any attention checks.

Data for this project was collected concurrently with data for a second project (described at http://osf.io/2trbk) data collection for the two projects was administered in this manner in order to ensure that the samples are not contaminated (i.e. did not contain the same participants) as although the projects were not intended to be analysed or reported together, their structural similarity could cause unexpected effects for participants who participated in both (e.g. by resulting in unblinding). This method of data collection and the intention to analyse and report the studies separately was documented in the pre-registration for both studies.

Measures

Demographics. These items included questions regarding age, gender, highest level of education completed, annual household income, and political ideology.

Intention. Intention was measured as the mean of three items (1= Strongly Disagree, 5 = Strongly Agree) regarding intention to engage in the referent behaviour "have a flu vaccination in the next flu season" (e.g. "I intend to have a flu vaccination in the next flu season"). Higher scores indicate greater intention to have the vaccination (α = 0.98).

Severity. Participants indicated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items that indicated that the negative impact of flu is severe (e.g. "The flu is a serious illness for someone like me"). The three items were averaged to create a

composite score. Higher scores indicate greater perceived severity of seasonal influenza (α = 0.67).

Susceptibility. Participants indicated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with two items that indicated that without a seasonal influenza vaccination they are vulnerable to the negative impacts of seasonal influenza (e.g. "Without a flu vaccine, I am vulnerable to contracting the flu in the next flu season") and one item indicating that without a seasonal influenza vaccination they are not likely to get seasonal influenza ("Even if I don't get a flu vaccination, I don't think I'm likely to get the flu in the next flu season"). Items were reversed as appropriate and the three items were averaged to create a composite score. Higher scores indicate greater perceived susceptibility to negative impacts of seasonal influenza (α = 0.72).

Maladaptive Response Rewards. Participants indicated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items that indicated that there are benefits of not receiving a seasonal influenza vaccination (e.g. "Not getting the flu vaccine next flu season would have some advantages for me"). The three items were averaged to create a composite score. Higher scores indicate greater perceived maladaptive response rewards (α = 0.57).

Self-efficacy. Participants indicated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with two items that indicated that they would be capable of engaging in the referent behaviour if they wished to do so (e.g. "I'd be able to get a flu vaccine in the next flu season if I wanted to"), and one item that indicated that it would be difficult for them to get the seasonal influenza vaccination ("Getting a flu vaccination in the next flu season would be difficult for me"). Items were reversed as appropriate and the three items were averaged to create a composite score. Higher scores indicate greater self-efficacy (α = 0.74).

Response Efficacy. Participants indicated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items that indicated that receiving the seasonal influenza vaccination would be effective in reducing vulnerability and severity of seasonal influenza (e.g. "Having a flu vaccination would stop me from getting the flu in the next flu season"). The three items were averaged to create a composite score. Higher scores indicate greater perceived response efficacy (α = 0.75).

Response Costs. Participants indicated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items that indicated that there are costs (including non-financial costs) associated with receiving the seasonal influenza vaccination (e.g "Being vaccinated against the flu is painful"). The three items were averaged to create a composite score. Higher scores indicate greater perceived response costs (α = 0.66).

Data analysis

We used R (Version 3.5.1; R Core Team, 2018) and the R-packages *broom* (Version 0.5.1; Robinson & Hayes, 2018), *dplyr* (Version 0.8.0.9002; Wickham, François, Henry, & Müller, 2018), *here* (Version 0.1; Müller, 2017), *knitr* (Version 1.21; Xie, 2015), *labelled* (Version 1.1.0; Larmarange, 2018), *papaja* (Version 0.1.0.9842; Aust & Barth, 2018), *readr* (Version 1.3.1; Wickham, Hester, & Francois, 2017), and *tableone* (Version 0.9.3; Yoshida & Bohn., 2018) for all our analyses and the compilation of this manuscript.

Ethics

This study underwent ethical review by the Deakin University Human Ethics Advisory Group (Health); reference number: HEAG-H 118_2018.

Results

Descriptive statistics

Pearson's product-moment correlations were calculated to assess the relationships between PMT constructs. As shown in Table 2, the constructs were correlated with each other as expected. Specifically, there were significant positive correlations between intention and severity, vulnerability, response efficacy, and self-efficacy. We observed negative correlations between intention and both maladaptive response rewards and response costs. maladaptive response rewards was negatively correlated with all components other than response costs. Response cost were negatively correlated with all variables except maladaptive response rewards. Maladaptive response rewards and response costs were positively correlated with each other.

Regression analysis

Multiple linear regression was conducted to examine the relationship between intention and PMT variables in combination. While there are concerns about the appropriateness of Pearson's correlations and OLS regression with Likert response data (Liddell & Kruschke, 2018), alternative approaches remain technically complex for sums of Likert scales as per the data from this study. The data are analysed as per the pre-registered analytic approach, which is consistent with the literature as a whole and therefore more comparable to prior findings. The data are available for re-analysis under different modelling assumptions. The overall model was significant ($R^2 = .66$, 90% *CI* [0.60, 0.69], $F(28,513) = 36.35$, $p < .001$). As shown in Table 3, maladaptive response rewards, severity, susceptibility, response efficacy and self-efficacy were all unique predictors of intention. However, response cost was not. Based on both the beta weights and structure coefficients, response efficacy was the strongest predictor of intention to vaccinate. Four participants (0.73% of total n) were excluded from the regression analysis due to

missing data. Due to the very low rate of missingness, imputation of missing values was not considered necessary.

In order to ensure that the results were robust after controlling for demographic characteristics, a regression model with demographic measures included was also conducted. In this model, age, gender, education, household income, and ideology (general) were also included as predictors of intention. The overall model remained significant and the pattern of results for PMT constructs was unchanged ($R^2 = .66$, 90% *CI* [0.60, 0.69], $F(28,513) = 36.35$, $p < .001$).

Discussion

In this study, we examined whether Protection Motivation Theory constructs predict intention to receive the seasonal influenza vaccination. Importantly, this is the first study to investigate all six of the major PMT constructs (maladaptive response rewards, severity, susceptibility, response efficacy, self-efficacy, and response costs) in the context of influenza vaccination. The findings build on prior research that has used the theoretical constructs in isolation or in limited combinations. The research is broadly consistent with this previous research (Ernsting et al., 2011; Falato et al., 2011; Weinstein et al., 2007). Correlational findings provided support for the hypotheses derived from the theory. Multiple regression analysis demonstrated that the PMT constructs account for a large proportion of the variance in intention to vaccinate and that all PMT constructs other than response costs are unique predictors of intention (see Table 3). The following discussion integrates these findings with previous research, considers their theoretical and practical implications, and identifies directions for future research.

The findings that self-efficacy and response efficacy were unique predictors of intention is consistent with previous research that has applied these coping appraisal constructs to the prediction of influenza vaccination uptake (Ernsting et al., 2011; Falato et al., 2011; Weinstein et al., 2007). This is also consistent with a larger body of research that has used these constructs to responses to pandemic influenza (Bish et al., 2011) and other vaccination behaviours (Rambout, Tashkandi, Hopkins, & Tricco, 2014). Previous studies have found that perceived high response costs, such as thinking that vaccination can cause influenza (Weinstein et al., 2007) and feeling concerned about the side effects of vaccination (Falato et al., 2011; Freimuth et al., 2017) were negatively correlated with influenza vaccination behaviour. Response costs were correlated with intention at the bivariate level but were not associated with intention to vaccinate when controlling for other PMT constructs.

This apparent inconsistency likely reflects overlap between response costs and other constructs within the theory. Some researchers have justified excluding maladaptive response rewards from tests of PMT because of conceptual overlap between response costs and maladaptive response rewards (Grothmann & Patt, 2003). In this study, the correlation between the variables was significant ($r = 0.49$). Response costs was also highly correlated with self-efficacy ($r = -0.61$). Based on this pattern of correlations, it is difficult to justify excluding maladaptive response rewards rather than self-efficacy on the basis of high intercorrelations with response costs. Indeed, as noted by Kraha, Turner, Nimon, Zientek, and Henson (2012), exclusion of theoretically meaningful predictors may not be the optimal approach to dealing with collinearity. Instead a set of techniques have been proposed to assess relative importance and contribution of predictor variables within regression analyses even in the presence of high multicollinearity. This includes examination of structure coefficients as well as the more

commonly reported beta weights in order to understand the role of individual variables within a regression model in the presence of multicollinearity. This is the approach taken in the current manuscript. Structure coefficients can be used to examine the relationship between a single predictor and the $\hat{y}$ value estimated on the basis of all predictors included within a regression model (Kraha et al., 2012; Ziglari, 2017).

It is interesting to note that based on interpretation of the structure coefficients if response costs were the only predictor of $\hat{y}$ intention the variable would account for a substantial proportion of variance in intention. Indeed, examination of structure coefficients would indicate that of the coping efficacy constructs, response efficacy is the strongest single predictor of $\hat{y}$ intention and that response costs may be a stronger predictor than self efficacy. This is contrary to the interpretation of the beta weights, where response costs is not a significant predictor of intention.

The findings that susceptibility and severity were unique predictors of intention is consistent with previous research that has applied these threat appraisal constructs to the prediction of influenza vaccination uptake (Falato et al., 2011; Freimuth et al., 2017; Quinn et al., 2017; Weinstein et al., 2007). Maladaptive response rewards had a negative relationship with intention have the seasonal influenza vaccination when at the bivariate level and when controlling for the effect of other PMT constructs, consistent with PMT and with the limited previous research that found that intentions are negatively associated with maladaptive response rewards (Floyd et al., 2000). These findings suggest that previous researchers may have underestimated the value of PMT in understanding influenza vaccination by failing to measure this construct (Ernsting et al., 2011; Falato et al., 2011; Weinstein et al., 2007). Examination of both beta weights and structure coefficients in combination shows that of the threat appraisal constructs,

susceptibility is the strongest predictor of $\hat{y}$ intention, followed by maladaptive response rewards and then severity.

Understanding the role of maladaptive response rewards provides a relatively novel target for PMT-based intervention to increase vaccination uptake, i.e. decreasing the extent to which people believe that there may be social, personal, or financial advantages to contracting influenza and/or not receiving the vaccination. However, given the paucity of existing research investigating maladaptive response rewards it is not immediately apparent how maladaptive response rewards based intervention messages might be designed in this context.

Limitations

In this study, the maladaptive response rewards items measured unspecified "advantages" to not receiving the vaccine, as well as specific advantages of not incurring expenses with regards to time/money and not having to worry about safety of the vaccine. These items were selected on the basis of one of the only previous studies to investigate the maladaptive response rewards construct with regard to vaccination behaviour (Lagoe, 2013). While some individuals might perceive other advantages to not receiving the vaccination (e.g. that having influenza provides better natural immunity to subsequent infection than receiving the vaccination, see: McCarthy, 2016; Prematunge et al., 2014), the frequency and variety of these perceived advantages has not been systematically studied with regard to seasonal influenza vaccination. However, as the first study to demonstrate a relationship between this construct and intention in the context of seasonal influenza, we hope that this finding will help to inspire research that more purposively addresses this question.

A key limitation of this study is that, due to practical constraints, the current study was unable to gather data on seasonal influenza vaccination behaviour. However, previous research has found that intention to vaccinate does predict subsequent seasonal influenza vaccination uptake (Ernsting et al., 2011). Furthermore, while adaptive intentions do not perfectly predict behaviour there is a reliable and strong association between them across a wide range of contexts (Webb & Sheeran, 2006). It is also important to recognise that PMT suggests that the role of PMT constructs on behaviour are mediated through intention. As such, even if behaviour had been measured, a test of this part of the model would consist of a test of the relationship between intention and behaviour, rather than a test of any other PMT constructs and behaviour. As the intention-behaviour relationship has previously been established in other studies, we feel that the study still provides valuable insights into the pre-intentional components of PMT.

There is evidence that interventions that increase risk appraisal and coping appraisal can be effective at increasing vaccination uptake (Sheeran, Harris, & Epton, 2014). However, interventions have often been ineffective at bringing about changes risk appraisal (Parsons, Newby, & French, 2018). This research provides novel targets, such as maladaptive response rewards that can and should be examined when seeking to modify individuals' evaluations of the risks associated with seasonal influenza vaccination. Further, although relatively few studies have sought to increase efficacy appraisals (Parsons et al., 2018), this research provides further evidence of the importance of self-efficacy and response efficacy in predicting intention to vaccinate. However, while this study examined the relative predictive strength of PMT constructs in predicting intention through examination of beta weights and structure coefficients, as a cross-sectional study it necessarily cannot provide insight into which of these constructs would provide the most appropriate intervention targets. Although response efficacy is the strongest predictor of

intentions, it does not necessarily follow that interventions targeting response efficacy would be more effective or that changes in response efficacy would lead to the largest corresponding changes in intention.

Conclusion

This study demonstrates the benefits of applying psychological theory to problems such as reaching target vaccination coverage, and particularly in revealing unintuitive predictors. For example, the present results particularly highlight the importance of constructs like maladaptive response rewards, which was a significant predictor of intention but has tended to be ignored in both the vaccination and broader literatures. While many of the constructs contained with PMT have previously been investigated with regard to intention to receive the seasonal influenza vaccine, this is the first study to investigate all six PMT construct simultaneously. However, it remains to be seen if these cross-sectional results reflect viable mechanisms for the promotion of vaccination. Future studies should seek to manipulate PMT constructs in order to examine the extent to which changes in those constructs are causally related to change in intention to vaccinate and whether such changes can be successful in bringing about subsequent increases in vaccination uptake. As this study shows, it is critical that such studies investigate all six PMT constructs together to provide a more accurate picture of which PMT beliefs are truly influential in increasing intention to receive the seasonal influenza vaccination.

References

Aust, F., & Barth, M. (2018). *papaja: Create APA manuscripts with R Markdown*. Retrieved from https://github.com/crsh/papaja

Bish, A., Yardley, L., Nicoll, A., & Michie, S. (2011). Factors associated with uptake of vaccination against pandemic influenza: A systematic review. *Vaccine*, *29*(38), 6472–6484.

CDC. (2018, October). Estimates of flu vaccination coverage among children — united states, 2017–18 flu season. Retrieved from https://www.cdc.gov/flu/fluvaxview/coverage-1718estimates.htm

Dini, G., Toletone, A., Sticchi, L., Orsi, A., Bragazzi, N. L., & Durando, P. (2018). Influenza vaccination in healthcare workers: A comprehensive critical appraisal of the literature. *Human Vaccines & Immunotherapeutics*, *14*(3), 772–789.

Ernst, K., & Jacobs, E. T. (2012). Implications of philosophical and personal belief exemptions on re-emergence of vaccine-preventable disease: The role of spatial clustering in under-vaccination. *Human Vaccines & Immunotherapeutics*, *8*(6), 838–841.

Ernsting, A., Lippke, S., Schwarzer, R., & Schneider, M. (2011). Who participates in seasonal influenza vaccination? Past behavior moderates the prediction of adherence. *Advances in Preventive Medicine*, *2011*.

Falato, R., Ricciardi, S., & Franco, G. (2011). Influenza risk perception and vaccination attitude in medical and nursing students during the vaccination campaigns of 2007/2008 (seasonal influenza) and 2009/2010 (h1n1 influenza). *La Medicina Del Lavoro*, *102*(2), 208–215.

Flannery, B., Chung, J. R., Thaker, S. N., Monto, A. S., Martin, E. T., Belongia, E. A., … others. (2017). Interim estimates of 2016-17 seasonal influenza vaccine effectiveness-united states, february 2017. *Morbidity and Mortality Weekly Report*, *66*(6), 167–171.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology*, *30*(2), 407–429.

Freimuth, V. S., Jamison, A., Hancock, G., Musa, D., Hilyard, K., & Quinn, S. C. (2017). The role of risk perception in flu vaccine behavior among african-american and white adults in the united states. *Risk Analysis*, *37*(11), 2150–2163.

Grohskopf, L. A. (2018). Prevention and control of seasonal influenza with vaccines: Recommendations of the advisory committee on immunization practices—united states, 2018–19 influenza season. *MMWR. Recommendations and Reports*, *67*. doi:10.15585/mmwr.rr6703a1

Grothmann, T., & Patt, A. (2003). Adaptive capacity and human cognition. In.

Health, U. D. of, Disease Prevention, H. S. O. of, & Promotion, H. (n.d.). Healthy people 2020. Retrieved from https://www.healthypeople.gov/node/6360/data_details#revision_history_header

Hofstetter, A. M., Lacombe, K., Klein, E. J., Jones, C., Strelitz, B., Jacobson, E., … others. (2018). Risk of rotavirus nosocomial spread after inpatient pentavalent rotavirus vaccination. *Pediatrics*, *141*(1), e20171110.

Kraha, A., Turner, H., Nimon, K., Zientek, L., & Henson, R. (2012). Tools to support interpreting multiple regression in the face of multicollinearity. *Frontiers in Psychology*, *3*, 44.

Lagoe, C. (2013). *An Exploration of the Influence that Source Credibility and Fear have on MMR Vaccination Intentions* (PhD). University of Connecticut - Storrs. Retrieved from https://opencommons.uconn.edu/dissertations/166/

Larmarange, J. (2018). *Labelled: Manipulating labelled data*. Retrieved from https://CRAN.R-project.org/package=labelled

Liddell, T. M., & Kruschke, J. K. (2018). Analyzing ordinal data with metric models: What could possibly go wrong? *Journal of Experimental Social Psychology*, *79*, 328–348.

MacDonald, N. E., & others. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*, *33*(34), 4161–4164.

Maddux, J. E., & Rogers, R. W. (1983). Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change. *Journal of Experimental Social Psychology*, *19*(5), 469–479.

McCarthy, K. (2016, October). Does the Flu Provide Better Immunity Than a Flu Shot? *Well*. Retrieved from https://well.blogs.nytimes.com/2016/10/28/does-the-flu-provide-better-immunity-than-a-flu-shot/

Müller, K. (2017). *Here: A simpler way to find your files*. Retrieved from https://CRAN.R-project.org/package=here

Parsons, J. E., Newby, K. V., & French, D. P. (2018). Do interventions containing risk messages increase risk appraisal and the subsequent vaccination intentions and uptake?–a systematic review and meta-analysis. *British Journal of Health Psychology*.

Pop-Vicas, A., Rahman, M., Gozalo, P. L., Gravenstein, S., & Mor, V. (2015). Estimating the effect of influenza vaccination on nursing home residents' morbidity and mortality. *Journal of the American Geriatrics Society*, *63*(9), 1798–1804.

Prematunge, C., Corace, K., McCarthy, A., Nair, R. C., Roth, V., Suh, K. N., & Garber, G. (2014). Qualitative motivators and barriers to pandemic vs. Seasonal influenza vaccination among healthcare workers: A content analysis. *Vaccine*, *32*(52), 7128–7134.

Quinn, S. C., Jamison, A. M., Freimuth, V. S., An, J., & Hancock, G. R. (2017). Determinants of influenza vaccination among high-risk black and white adults. *Vaccine*, *35*(51), 7154–7159.

Rambout, L., Tashkandi, M., Hopkins, L., & Tricco, A. C. (2014). Self-reported barriers and facilitators to preventive human papillomavirus vaccination among adolescent girls and young women: A systematic review. *Preventive Medicine*, *58*, 22–32.

R Core Team. (2018). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/

Robinson, D., & Hayes, A. (2018). *Broom: Convert statistical analysis objects into tidy tibbles*. Retrieved from https://CRAN.R-project.org/package=broom

Rothman, A. J. (2004). " Is there nothing more practical than a good theory?": Why innovations and advances in health behavior change will arise if interventions are used to test and refine theory. *International Journal of Behavioral Nutrition and Physical Activity*, *1*(1), 11.

Schmid, P., Rauber, D., Betsch, C., Lidolt, G., & Denker, M.-L. (2017). Barriers of influenza vaccination intention and behavior–a systematic review of influenza vaccine hesitancy, 2005–2016. *PloS One*, *12*(1), e0170550.

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.

Stone, E. G., Morton, S. C., Hulscher, M. E., Maglione, M. A., Roth, E. A., Grimshaw, J. M., … Shekelle, P. G. (2002). Interventions that increase use of adult immunization and cancer screening services: A meta-analysis. *Annals of Internal Medicine*, *136*(9), 641–651.

Thompson, W. W., Comanor, L., & Shay, D. K. (2006). Epidemiology of seasonal influenza: Use of surveillance data and statistical models to estimate the burden of disease. *The Journal of Infectious Diseases*, *194*(Supplement_2), S82–S91.

U.S. Department of Health and Human Services Office of Disease Prevention and Health Promotion. (2013). Healthy people 2020. Retrieved from https://www.healthypeople.gov/node/6360/data_details#revision_history_header

Webb, T., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin*, *132*(2), 249.

Weinstein, N. D., Kwitel, A., McCaul, K. D., Magnan, R. E., Gerrard, M., & Gibbons, F. X. (2007). Risk perceptions: Assessment and relationship to influenza vaccination. *Health Psychology*, *26*(2), 146.

Wickham, H., François, R., Henry, L., & Müller, K. (2018). *Dplyr: A grammar of data manipulation*. Retrieved from https://CRAN.R-project.org/package=dplyr

Wickham, H., Hester, J., & Francois, R. (2017). *Readr: Read rectangular text data*. Retrieved from https://CRAN.R-project.org/package=readr

Xie, Y. (2015). *Dynamic documents with R and knitr* (2nd ed.). Boca Raton, Florida: Chapman; Hall/CRC. Retrieved from https://yihui.name/knitr/

Yan, S., Weycker, D., & Sokolowski, S. (2017). US healthcare costs attributable to type a and type b influenza. *Human Vaccines & Immunotherapeutics*, *13*(9), 2041–2047.

Yoshida, K., & Bohn., J. (2018). *Tableone: Create 'table 1' to describe baseline characteristics*. Retrieved from https://CRAN.R-project.org/package=tableone

Ziglari, L. (2017). Interpreting multiple regression results: β Weights and structure coefficients. *General Linear Model Journal*, *43*(2), 13–22.

Table 1
Demographic characteristics of participants

	Overall
n	547
Age in years (mean (sd))	36.81 (11.62)
Highest level of education (%)	
Less than high school	3 (0.5)
High school diploma or GED	53 (9.7)
Some college	117 (21.4)
Associate's degree	53 (9.7)
Bachelor's degree	226 (41.3)
Professional or Masters degree	82 (15.0)
Doctorate	13 (2.4)
Gender (%)	
Male	256 (46.8)
Female	290 (53.0)
Non-binary	1 (0.2)
Annual household income (%)	
Less than $10,000	26 (4.8)
$10,000 - $19,999	40 (7.3)
$20,000 - $29,999	55 (10.1)
$30,000 - $39,999	69 (12.6)
$40,000 - $49,999	74 (13.5)
$50,000 - $59,999	51 (9.3)
$60,000 - $69,999	48 (8.8)
$70,000 - $79,999	41 (7.5)
$80,000 - $89,999	42 (7.7)
$90,000 - $99,999	32 (5.9)
$100,000 - $149,999	49 (9.0)
More than $150,000	15 (2.7)
Prefer not to say	5 (0.9)
Ideology - General (mean (sd))	4.36 (2.69)
Ideology - Economic (mean (sd))	4.86 (2.74)
Ideology - Social (mean (sd))	3.99 (2.89)

Table 2

Correlations between PMT variables

Variable	*M*	*SD*	1	2	3	4	5	6
1. Intention	3.20	1.54						
2. Maladaptive response rewards	3.26	0.95	-.48**					
3. Severity	3.70	0.88	.42**	-.18**				
4. Susceptibility	3.38	0.95	.63**	-.36**	.49**			
5. Response Efficacy	2.99	1.02	.64**	-.28**	.32**	.51**		
6. Response Costs	2.37	0.95	-.38**	.49**	-.12**	-.32**	-.15**	
7. Self-Efficacy	4.25	0.81	.34**	-.29**	.15**	.31**	.11*	-.61**

Table 3

Linear regression of vaccination intention on PMT constructs.

Predictor	β	*b*	95% *CI*	Structure coefficients	*t*(536)	*p*
Intercept	0.00	-0.35	[-1.21, 0.51]		-0.8	.421
Response Efficacy	0.39	0.60	[0.50, 0.69]	0.81	12.44	< .001
Susceptibility	0.25	0.40	[0.29, 0.52]	0.81	6.91	< .001
Maladaptive Response Rewards	-0.20	-0.33	[-0.43, -0.23]	-0.61	-6.34	< .001
Severity	0.12	0.21	[0.10, 0.31]	0.55	3.78	< .001
Self-efficacy	0.11	0.22	[0.09, 0.34]	0.44	3.30	.001
Response Costs	-0.05	-0.08	[-0.20, 0.03]	-0.48	-1.40	.162

Note. $R^2 = .62$, 90% *CI* [0.57, 0.65], $F(6,536) = 142.97$, $p < .001$

Predictors are presented in order of strength as determined by β weights