Vaccine 37 (2019) 4124–4132

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

The relative effects of determinants on Chinese adults' decision for influenza vaccination choice: What is the effect of priming?

Qiuyan Liao [a,*], Wendy Wing Tak Lam [a], Carlos King Ho Wong [b], Cherry Lam [a], Jing Chen [c], Richard Fielding [a]

[a] Division of Behavioural Sciences, School of Public Health, The University of Hong Kong, Hong Kong, China
[b] Department of Family Medicine and Primary Care, The University of Hong Kong, Hong Kong, China
[c] School of Nursing, The University of Hong Kong, Hong Kong, China

ARTICLE INFO

Article history:
Received 22 October 2018
Received in revised form 20 May 2019
Accepted 24 May 2019
Available online 8 June 2019

Keywords:
Influenza vaccination
Preference
Priming
Risk judgment

ABSTRACT

Objectives: To assess the relative effects of altering different factors (attributes) related to adults' decision for influenza vaccination choice, and whether priming modifies these relative effects.

Methods: Chinese adults were randomly allocated to either a control condition (non-risk related video), or one of the three health risk-priming conditions (disease (influenza) risk video, intervention (vaccine) risk video, or non-specific (air pollution) risk video), each comprising ~200 participants, prior to a discrete choice experiment survey. Mixed logit modelling estimated the relative effects of pre-determined attributes influencing vaccination choice.

Results: Across all four conditions, for determining vaccination choice, Vaccine Efficacy had a greater effect than social cues (community vaccination coverage rate (CVCR) and doctors' advice) but social cues can compensate for the effect of "uncertain" vaccine safety; influenza case-fatality ratio (CFR) became dominantly important among all included attributes when it reached 20%; vaccination preference increased when a CVCR changed incrementally from 5% to 60% but declined thereafter when the CVCR reached 80%. Compared with Control participants, a CVCR increased by 80% had a smaller effect for participants primed by intervention risk on vaccination choice, while the effect of influenza risk relative to vaccine risk increased following disease risk priming.

Conclusion: While increasing confidence on vaccine efficacy is more important for influenza with less severe consequences, highlighting disease consequences becomes increasingly important when its CFR increases, for promoting vaccination uptake. For a new vaccine with uncertain safety, involving doctors and early vaccine takers to validate vaccine safety should be important. Brief exposure to influenza/vaccine risk didn't increase the effect of specific risk on vaccination choice but may change the relative weight of disease versus intervention risk when individuals make trade-off for vaccination decision. Free riding on herd immunity may increase when community vaccination coverage is high particularly following intervention risk priming.

1. Introduction

Influenza produces a huge disease burden worldwide [1]. Globally, seasonal influenza attacks 5–10% of adults annually while the case-fatality ratio is low, around 0.1% [2]. However, the impact of an influenza pandemic could be devastating such as the 1918 pandemic [3]. The last pandemic, the 2009 influenza A/H1N1 pandemic (A/H1N1), seemed relatively mild with an attack rate of ~10% and case-fatality ratio (CFR) of ~1%, yet still accounted for significant numbers of death [4]. Predicting how severe the next pandemic is difficult. Potential candidates could be the avian influenza A/H5N1 of which CFR was estimated to be around 14–33% [5]. Vaccination is currently the most effective strategy for preventing influenza if the vaccine strain closely matches the predominant virus strain [6]. Vaccinated individuals benefit directly, and unvaccinated individuals indirectly through reduced exposure to infected individuals if community vaccination coverage reaches or exceeds 60% (herd immunity) [7]. Yet in many populations, seasonal influenza vaccination uptake rates remain low [8]. In Hong Kong, priority groups including pregnant women, those who aged 6–72 months, those who aged 50 years or above, healthcare workers and persons with intellectual disability or receiving disability

* Corresponding author at: School of Public Health, The University of Hong Kong, 7 Sassoon Road, Pokfulam, Hong Kong, China.

E-mail addresses: qyliao11@hku.hk (Q. Liao), wwtlam@hku.hk (W.W.T. Lam), carlosho@hku.hk (C.K.H. Wong), cylam1@hku.hk (C. Lam), pianogal@hku.hk (J. Chen), fielding@hku.hk (R. Fielding).

https://doi.org/10.1016/j.vaccine.2019.05.072
0264-410X/

allowance are recommended and subsidized for their annual influenza vaccination [9], but there is no specific recommendation or subsidy for the influenza vaccination of adults out of the priority groups unless there is a pandemic [10]. Vaccination coverage was generally low in Hong Kong, being around 30% in children of the priority groups [11] and even lower in the general adults (~20% received seasonal influenza vaccine and ~1% received the 2009 influenza A/H1N1 pandemic vaccine) [10].

1.1. Vaccination-related decision making

The utility maximization theory (UMT) assumes that of different options provided for consumers, each contains properties of pleasure (positive utility) and pain (negative utility), and the one with maximum utility would be most preferred by consumers over alternatives [12]. The UMT conventionally measures the utility of different options in terms of their prices or monetary value (objective utility). Following this idea, Subjective (expected) Utility Theory (SUT) was developed, assuming that choices are made to maximize the utility perceived or valued by individuals (subjective utility) rather than objective utility [13]. As extensions of SUT, cognitive behavioural theories or "value-expectancy models" were developed, assuming that individual behaviours result from the interaction of personal judgement of the probability and severity of outcomes (perceived probability × perceived severity) through a reasoned and deliberative process to maximize expected utility [14]. However, a wide range of deviations were identified in the application of these normative theories in explaining people's actual behaviours [15,16]. More recently, interest in dual-process models of decision making has increased [17]. These models propose that individual decision making is not merely a conscious, deliberative and systematic reasoning process that aims to maximize expected utility but also involves an unconscious, heuristic and affective process [18,19]. Dual-process models differ from normative behavioural decision theories in three assumptions: first, individual behaviour is, in part, driven by internal cues (heuristics, preconceptions and affect) which facilitate fast but sometimes imperfect decisions subject to biases or involving incomplete information; second, individuals are social actors whose behaviours are partly driven by external cues that indicate social approval or group expectations, norms, and; third, internal and external cues interacted with individual self-regulation to steer actions [17].

With respect to vaccination, normative behavioural models are commonly used for explaining people's vaccination decisions, presuming that in deciding to be vaccinated or not, people trade off risks and benefits based on the characteristics of the disease and available vaccine [20,21]. However, increasingly studies indicate that vaccination decisions do not completely follow such a rule-based reasoning process, and that unconscious, heuristic and affective processes are needed to understand vaccination decisions. Studies have suggested that vaccination decisions can be facilitated by following a doctors' recommendation, representing an external cue or heuristic that enables quick judgement and decision-making, particularly among individuals with high levels of trust in their doctors [22,23]. There is evidence that affective processes have a greater influence than do cognitive risk estimates in shaping individual vaccination decision-making [24,25]. In addition, individual vaccination decisions can be shaped by the vaccination choices of others in one's social networks [26,27]. The vaccination uptake of others in a community provides three external cues that help shape individual vaccination decisions. First, vaccination coverage indicates uptake and thereby how acceptable the vaccination is to community members (descriptive norm). Thus, with increasing, and importantly, visible, vaccine uptake, individuals may increasingly conform to group trends in vaccination decisions, an "imitate-the-majority" strategy [27,28]. Second, late vaccinators rely on early vaccinators to validate a vaccine's safety, adopting a wait-and-see strategy in vaccination decisions if only a minority of the community is vaccinated [26]. Third, as increasing numbers in the community are vaccinated, the probability of unvaccinated individuals encountering infected people declines. If vaccination coverage of the population is sufficiently high, those who remain unvaccinated may free-ride on herd immunity, avoiding any vaccination-associated costs, assuming that these individuals understand herd immunity [26,29].

1.2. Priming and behavioural change

Dual-process models of decision-making highlight the possibility of activating automatic heuristic and affective processes by providing external cues, priming, to change information processing and possibly behaviour [30]. Instead of exerting a direct effect on behaviours, such cues affect behaviours by activating "situated conceptualizations" [31], the automatic mental associative networks established over time through experience [32]. Once such associative networks have been encoded in memory, activating any elements of the associations with priming stimuli (cues) automatically activates other associative elements in the network, leading to unconscious effects on judgment and behaviours [32]. For instance, providing a "clean and fresh" citrus smell, an element associated with cleanness in memory, successfully improved hand hygiene compliance among health professional [33]. This may reflect the priming stimuli automatically activating implicit affect associated with goals or end states and their associations with the desired behaviours, thereby influencing behaviours [34]. Additionally, when specific mental associations are activated, other competing schemas are relatively inhibited due to limited attention capacity, which leads to bias in information processing and affects subsequent judgement and behaviours [35].

During influenza pandemics, information about both influenza and vaccination risk are widespread in, often sensationalized, media content competing for public attention [36]. There was evidence that public attention to, perception of disease risk and decision for vaccination during influenza pandemic followed media coverage rather than epidemiologic curve of the disease [37,38]. In addition, exposure to negative information about vaccination from media was associated with later expression of negative opinions about vaccination, perceived greater vaccine risk or refusal of vaccination [39–41]. All these studies examined the influence of a routine pattern of exposure to specific risk information (e.g. people exposed to specific risk information in a certain period through particular sources) on vaccination decision. However, it is also possible that immediately before vaccination happens, individuals change their judgement and vaccination choice due to incidental exposure to brief information about influenza or vaccine risk which automatically activates their existing mental associations or implicit affect associated with influenza/vaccination. That is the priming effect. When automatic associations with influenza risk are activated, this may inhibit competing associations with vaccination risk, biasing attention towards influenza risk and subsequently vaccination decision, and vice versa. This is significantly important for promoting vaccination uptake because it means that giving brief information about influenza risk in healthcare settings where vaccines are readily available may cue real-time decision for vaccination uptake among individuals who visit these settings for other reasons. However, such effect and its potential mechanisms are yet to be empirically tested.

1.3. Discrete choice experiment

Discrete choice experiment (DCE) is commonly used in health care implementation research [42]. It decomposed medical intervention, like vaccination program, into different attributes, such as vaccine efficacy and cost, each attribute being further characterized by attribute levels (e.g. vaccine efficacy of 40%, 60% or 80%) [42]. DCE presents a series of choice sets, and how people trade-off among different attributes and levels indicates the relative importance of the attributes and attribute levels on decision preference. Existing DCE studies examining vaccination decisions mostly focus on how individuals traded off attributes relevant to the disease and vaccine provided [43,44]. Two DCE studies examining public acceptance of vaccination in hypothetical pandemics included attributes relevant to social cues (advice from others and tone of media reports) [45,46]. However, none examined how vaccination preference changed as a function of increasing population vaccination coverage, an important social cue in vaccination decisions [10,26,27]. This study would add to existing knowledge by examining the relative importance of attributes relevant to the disease and vaccine as well as those relevant to external social cues on vaccination decision.

1.4. Research objectives and hypotheses

This study combined DCE and priming manipulation to examine (1) the relative effects of varying decision determinants on vaccination choice, (2) if the relative effects of these determinants on vaccination choice vary by priming condition (i.e. exposure to brief specific risk information).

For the first objective, based on current theories of vaccination decisions and relevant empirical studies [20–27], seven attributes were suggested to be key determinants of vaccination decision: two disease-relevant attributes (susceptibility (influenza Infection Probability: ease of infection) and severity (influenza CFR: the probability of death once infected), three vaccine-relevant attributes (Vaccine Efficacy, Vaccine Safety and out-of-pocket Vaccination Cost), and two attributes indicating external social cues (Doctors' Advice and Community Vaccination Coverage Rate (CVCR)) (Table 1). We hypothesize that i. Probability of choosing vaccination increases with the increases in Infection Probability, CFR, Vaccine Efficacy and Vaccine Safety, doctors' encouragement, and the decrease in Vaccination Cost, and; ii. Probability of choosing vaccination follows an n-shaped curve, initially rising to an apogee, thereafter falling as a function of increasing CVCR; and iii. External social cues (doctors' encouragement and CVCR) are more important than vaccine-relevant attributes in determining vaccination choice. Since the relative effects of disease-relevant attributes depends on pandemic severity, the effects of disease-relevant attributes relative to other attributes were examined across pandemics of two severity levels: the 2009 influenza A/H1N1-like (mild) pandemic and the influenza A/H5N1-like (severe) pandemic. We hypothesize that vaccine-relevant attributes are more important than disease-relevant attributes for a mild pandemic but become less important than disease-relevant attribute for a severe pandemic, for determining vaccination decision.

For the second objective, four video clips (each ~2 min' duration) were developed to represent four priming conditions: one control (non-risk related), one disease (influenza) risk prime, one intervention (vaccine) risk prime and one non-specific (air pollution) risk prime. The non-specific risk priming condition was included as an irrelevant risk prime that may activate a mental schema/affect unrelated to the desired behaviour (influenza vaccination) but a mental schema linking to concerns about health. A prime's ability to induce the desired behaviour possibly depends on the strength of the link between the prime-activated mental schema and the desired behaviour [47]. Therefore, we assume that the non-specific risk prime will bias attention to neither influenza nor vaccine risk in vaccination decision. For influenza-risk and vaccine-risk priming conditions, we hypothesize that compared with Control participants, influenza-relevant attributes for participants primed by influenza risk while vaccine-relevant attributes for participants primed by vaccine risk will be more important in determining vaccination choice.

Table 1
Attributes and their relevant levels included in the discrete choice experiment.

Attributes	Level of the attribute
Infection probability[a]	5%
	10%
	20%
	30%
Case-fatality ratio[b]	0.1%
	0.2%
	2%
	10%
Vaccine safety	Safe with mild side effects (similar to seasonal influenza vaccine)
	Uncertain, it is a new vaccine
Vaccine efficacy	50%
	80%
Out of pocket cost of the vaccination	HK$0
	HK$100 (US$12.8)
	HK$200 (US$25.6)
	HK$300 (US$38.5)
Community vaccination coverage rate	5%
	30%
	60%
	80%
Doctors' advice	Neutral/no opinion
	Encourage

[a] The proportion of those who are infected over the total number of those who expose to the virus.
[b] The proportion of those infected who die from the infection over the total number of confirmed cases of infection.

2. Methods

2.1. DCE questionnaire

The chosen attributes were first validated against findings from a local study on pandemic vaccine acceptance [10], a pilot study, and finalized by the research team (Table 1). Levels of each attribute were selected to ensure that they were realistic for real-life situations and that the difference between the lowest and largest attribute levels was sufficient to capture participants' attention (Table 1). From all possible attribute profiles ($4 \times 4 \times 2 \times 2 \times 4 \times 4 \times 2 = 2048$ hypothetical profiles based on levels of each attribute in Table 1), a fractional factorial design based on orthogonal arrays (ORTHOPLAN procedure, IBM SPSS Statistics for Windows, Version 22.0) was used to select 32 hypothetical profiles. Each hypothetical profile describes one hypothetical vaccination programme scenario during specific pandemic using the chosen attributes and attribute levels. These 32 selected hypothetical profiles were used to construct16 choice sets, each comprised two hypothetical profiles (Scenario A and Scenario B). For each choice set, participants were asked about their vaccination choice preference in Scenario A versus Scenario B. If participants show no preference for either scenario, they can choose "Neither A nor B" (the "opt-out" option). To minimize disinterest and response fatigue, two versions of the questionnaire were created by randomly assigning the 16 choice sets to either version. Therefore, each version covered eight main choice sets plus one choice set within which probability of choosing vaccination is logically greater in Scenario A than in Scenario B for rationality test, prior to the main choice sets (S1). We assumed probability of choosing vaccination was logically greater in Scenario A in the choice set for rationality test because compared with Scenario B, Scenario A was characterized by a severer pandemic (with greater Infection Probability and

CFR), greater Vaccine Efficacy and Vaccine safety but lower Vaccination Cost, and that the vaccine was recommended by doctors, while CVCR held the same across the two scenarios. This extra choice set for rationality test was included to identify participants being potentially 'irrational' or not able to understand the choice tasks. Participants who 'failed' in the rationality test (choosing vaccination in Scenario B rather than A) would be excluded for the sensitivity analysis.

2.2. The primes

The control video showed a drive through natural scenery, minus audio or text. The contents of the three risk-priming video clips were constructed based on relevant information from the official websites of World Health Organization, Hong Kong Center for Health Protection and local newspaper reports. Each was presented as a television news report. Specifically, the disease risk prime described health consequences of influenza infection from mild to severe and ease of interpersonal transmission; the intervention risk prime described potential side effects of influenza vaccination, ranging from common mild side effects to rare serious consequences, as well as media-derived controversy over vaccine safety, and; the non-specific risk prime described the seriousness of local air pollution and potential health consequences. In all three risk primes information was presented in equal graphical, audio and textual formats. All videos made no mention of herd immunity. To assuage any residual concerns over vaccine safety, participants in the intervention risk-priming condition each received a post-study debriefing on the purpose of the video after completing the survey. Pilot testing was conducted to ensure that the risk priming videos were more threatening than the control before they were formally used in the study, because it is suggested that emotional valence of threatening stimuli is automatically evaluated very early during information processing [48], which consequently activates associated mental schema, creating bias toward the threat during subsequent information processing stages [49]. However, materials evoking strong fear were avoided to prevent stimulus avoidance responses [50,51].

2.3. Participants and procedure

Chinese-speaking and literate Hong Kong residents (aged ≥18 years), comprising over 90% of the adult population of Hong Kong were recruited. Since influenza vaccination history is one important predictor of future influenza vaccination behaviour [10,52] and ever influenza vaccination uptake rate was low (~20%) among general Hong Kong adults, we excluded subjects reporting prior influenza vaccination as adults. Eligible subjects were recruited from public venues and non-government organizations distributed over the 18 districts of Hong Kong. All data collection occurred between December 2015 and December 2016. Following fully-informed written consent, participants were randomly allocated, based on study recruitment order, to one of the three risk-priming or the control conditions. Having viewed the assigned video, they were randomly allocated to complete one of the two versions of the DCE questionnaire. Thereafter, all participants completed the same survey part which in addition to demographic information, they were asked to complete questions about the video they viewed using the Self-Assessment Manikin (SAM) [53], one item assessing feeling of threat regarding the video they viewed, and three items assessing degree of risk-specific (influenza, vaccination and air pollution) worry (Appendix Table 1). The procedure was tablet-assisted (Samsung Galaxy Tab Pro 10.1, 16 GM). This study received prior ethical approval from the Institutional Review Board of the University of Hong Kong and Hospital Authority Hong Kong West Cluster.

2.4. Data analysis

Mixed logit modelling was used to assess the preference weight for each attribute or attribute level in determining vaccination choice preference under each priming condition (Eq. (1)). This model can accommodate individual-specific variation in preference and allow correlation within subjects over repeated choices [54]. The preference weights represent the implicit relative importance attached to each attribute level when evaluating alternatives. Probability of infection, CRF and out-of-pocket cost of the vaccination were coded as linear terms because their preference weights increased with their attribute levels in pre-testing for linear continuous effects.

$$\begin{aligned} Vi = {} & \beta0 + \beta1 \text{ “Infection Probability”} + \beta2 \text{ “Case} \\ & - \text{Fatality Ratio”} \\ & + \beta3 \text{ “Vaccine Safety”(uncertain vs. mild side effects)} \\ & + \beta4 \text{ “Vaccine Efficacy”(80\% vs. 50\%)} \\ & + \beta5 \text{ “Community Vaccination Coverage Rate”(30\% vs. 5\%)} \\ & + \beta6 \text{ “Community Vaccination Coverage Rate”(60\% vs. 5\%)} \\ & + \beta7 \text{ “Community Vaccination Coverage Rate”(80\% vs. 5\%)} \\ & + \beta8 \text{ “Vaccination Cost”} \\ & + \beta9 \text{ “Doctors' Advice”(encourage vs. “no opinion”)} \\ & + \text{error} \end{aligned} \quad (1)$$

In the equation, "i" represents the choice alternative; Vi represents the utility from each choice that respondents attribute to influenza vaccination; β0 is a constant reflecting respondents' preference for accepting flu vaccination relative to "declining vaccination in both scenarios (the opt-out choice)"; β1–β9 are coefficients of the attributes indicating the relative weights (preference weights) respondents place on given attribute levels. A significant ($p < 0.05$) coefficient in the model means that individuals differ between one attribute level and the reference level in making stated choices. The main model (Eq. (1)) was first tested for each of the four conditions. To test the interaction effects between video type and attributes on vaccination choice preference, three dummy variables were generated to represent each of the three risk-priming videos. Then interaction terms between risk video type and particular attributes were included into the main model (Eq. (1)) for the whole sample to examine potential priming effects. The models across the four conditions were compared against log-likelihood, Akaike Information Criterion (AIC), and McFadden R-square to assess goodness of fit [54]. A sensitivity analysis was conducted by re-running the main model for each condition and the main model with interactions among whole samples excluding participants who 'failed' the rationality test.

The relative importance of attributes in determining vaccination preference under each condition was evaluated by directly comparing their respective preference weights from the above mixed logistic models, and by calculating their relative contributions to vaccination choice in a case of 2009 influenza A/H1N1-like pandemic (probability of infection: 10%; case-fatality ratio: 1%) [4] and a case of influenza A/H5N1-like pandemic (probability of infection: 30%; case-fatality ratio: 20%) [5], respectively. This was done by dividing the difference in coefficient values between the highest and lowest level of that attribute by the sum of the differences of all attributes included in the experiment [45], with vaccination cost being set to zero. Statistical analyses were conducted using R version 3.4.0 (The R Foundation for Statistical Computing Platform, 2017).

3. Results

3.1. Participants

Eight hundreds participants completed the questionnaire with ∼200 being allocated to each of the four conditions: control (N = 200), disease (influenza) risk (N = 201), intervention (vaccine) risk (N = 201) and non-specific (air pollution) risk (N = 198). The influenza risk-primed participants included slightly fewer females while those primed by vaccine risk comprised slightly more better-educated participants compared to Control participants, but age, birth place, marital status, and household income were comparable across the four conditions (Table 2). The whole sample was comparable to the adult population of Hong Kong [55] in terms of gender (effect size (z) = 0.26), age (z = 0.20) and educational attainment (z = 0.25) distributions [56].

3.2. Rated threatening, affective valence and affective arousal of the risk priming videos

All three risk priming videos were rated to be significantly more threatening, more negative in affective valence and more affectively arousing than was the control video (Appendix Table 1). In addition, the non-specific risk priming video was rated to be significantly more threatening, more negative in affective valence and more affectively arousing than both the influenza and vaccine risk priming videos (Appendix Table 1). Reported risk-specific (influenza, vaccine and air pollution) worry was not significantly different across the four conditions or between any two conditions (Appendix Table 1).

3.3. Frequency of choice across choice set and version of the DCE questionnaire

Each of the two versions of the DCE questionnaire was completed by around 50% of the participants. The proportion of participants completing either version of the DCE questionnaire did not significantly differ by priming condition. Participants who completed the two versions of DCE questionnaire did not differ by their demographics and their frequency of choosing Scenario A, Scenario B or Neither in the rationality test. The frequencies of participants' choice across different choice sets and the two versions of DCE questionnaires are shown in Appendix Table 2. In the rationality test, over 80% of the participants chose vaccination in Scenario A for which vaccination probability was logically assumed to be greater than was it for Scenario B. Participants who chose Scenario B in the rationality test did not differ from other participants in terms of gender, age and educational attainment. For the main DCE choice tasks, 17.9–73.5% of the participants chose either Scenario A or Scenario B for vaccination.

3.4. Attribute (level) preference weights by priming condition

Across the four conditions, all attributes were significantly associated with vaccination choice preference (Table 3). In each condition, probability of choosing vaccination increased with the increases in influenza Infection Probability, influenza CFR, and Vaccine Efficacy, with Doctors' Recommendation, with Vaccine Safety changing from "uncertain" to "mild side effects", and with a decrease in Vaccination Cost. Probability of choosing vaccination increased as CVCR increased from 5% to 30% and from 30% to 60% but subsequently declined as CVCR further increased from 60% to 80% across all conditions. Although vaccination preference weight remained significant as a CVCR increased by 80% relative to a CVCR of 5% for Control participants, and participants primed by influenza risk and air pollution risk, it became insignificant for participants primed by vaccine risk. Whole sample analyses combining all four conditions examined the interaction effects between each risk video and different attributes, indicating a significant interaction between CVCR of 80% and vaccine-risk priming ($\beta = -0.29$, $p = 0.046$), and between CVCR of 80% and air-pollution-risk priming ($\beta = 0.35$, $p = 0.016$) in influencing vaccination choice. These interaction effects indicate that compared with Control participants, a CVCR increased by 80% had smaller (insignificant) effect on vaccination choice for participants primed by vaccine risk but a greater (significant) positive effect on vaccination choice for participants primed by non-specific risk. There was no significant interaction effect between video type and other attributes. The sensitivity analysis that re-ran the same mixed logit modelling for the whole sample and each priming condition after

Table 2
Characteristics of the whole sample and participants across the four priming/control conditions.

	Control (N = 200)	Influenza risk (N = 201)	Vaccine risk (N = 201)	Air pollution risk (N = 198)	Differences by condition (p)[c]	Total sample
Female	73.0%	57.2%[b]	66.2%	64.1%	0.011	65.1%
Age group (years)						
18–34	32.0%	36.3%	31.8%	26.8%	0.583	31.8%
35–54	35.5%	32.8%	37.8%	38.4%		36.1%
≥55	32.5%	30.8%	30.3%	34.8%		32.1%
Education						
≤Primary	17.0%	17.4%	15.4%[a]	17.7%	0.211	16.9%
Secondary	52.0%	41.3%	41.3%[a]	43.4%		44.5%
≥Tertiary	31.0%	41.3%	43.3%[a]	38.9%		38.6%
Birth place						
Hong Kong	55.5%	63.2%	60.2%	53.5%	0.191	58.1%
Other places	44.5%	36.8%	39.8%	46.5%		41.9%
Marital status						
Never married	29.0%	32.3%	32.8%	28.3%	0.682	30.6%
Married or once married	71.0%	67.7%	67.2%	71.7%		69.4%
Household income (HK$)[d]						
<10 K	28.0%	24.4%	25.4%	26.8%	0.475	26.1%
10–20 K	33.0%	26.9%	24.4%	30.8%		28.8%
20–40 K	20.5%	28.4%	25.9%	23.7%		24.6%
>40 K	18.5%	20.4%	24.4%	18.7%		20.5%

[a] $p < 0.05$.
[b] $p < 0.01$; indicating differences between the risk-priming conditions and the control condition based on Pearson Chi-square test.
[c] Indicating differences across the four conditions based on Pearson Chi-square test.
[d] HK$1 = US$0.128.

Table 3
Preference weights of attributes in overall and across the four risk-priming conditions.

Attribute and attribute level	Control (S.E.)	Influenza risk (S.E.)	Vaccine risk (S.E.)	Air pollution risk (S.E.)	Whole sample (S.E.)
Infection probability (per 10% increase)	0.43 (0.11)[c]	0.44 (0.10)[c]	0.48 (0.10)[c]	0.39 (0.11)[c]	0.32 (0.05)[c]
Case-fatality ratio (per 10% increase)	1.30 (0.23)[c]	1.10 (0.21)[c]	0.95 (0.22)[c]	0.70 (0.20)[c]	0.76 (0.09)[c]
Vaccine safety (reference level: mild)					
Uncertain	−0.90 (0.16)[c]	−0.41 (0.12)[c]	−0.52 (0.14)[c]	−0.48 (0.15)[b]	−0.40 (0.06)[c]
Vaccine efficacy (reference level: 50%)					
80%	1.60 (0.20)[c]	1.20 (0.19)[c]	1.41 (0.20)[c]	1.76 (0.24)[c]	1.19 (0.09)[c]
Community vaccination uptake rate (reference level: 5%)					
30%	0.64 (0.18)[c]	0.33 (0.16)[a]	0.39 (0.17)[a]	0.51 (0.18)[b]	0.38 (0.08)[c]
60%	0.94 (0.18)[c]	1.00 (0.18)[c]	0.89 (0.18)[c]	1.39 (0.21)[c]	0.90 (0.08)[c]
80%	0.65 (0.17)[c]	0.39 (0.15)[b]	0.20 (0.16)	0.77 (0.17)[c]	0.44 (0.07)[c]
Doctors' advice (reference level: Neutral no opinion)					
Encourage	0.86 (0.14)[c]	0.73 (0.13)[c]	0.56 (0.14)[c]	0.91 (0.17)[c]	0.63 (0.06)[c]
Vaccination cost (per HK$100 increase)	−0.32 (0.05)[c]	−0.29 (0.05)[c]	−0.30 (0.05)[c]	−0.34 (0.05)[c]	−0.27 (0.02)[c]
Log-likelihood	−1241.90	−1272.40	−1287.00	−1207.60	−5105.20
AIC	2577.81	2638.83	2668.07	2509.24	10304.35
McFadden R-square	0.16	0.15	0.15	0.17	0.14

Note: Numbers outside of the parentheses are the coefficients of the mixed logit models representing preference weight coefficient. S.E., Standardized Error; AIC, Akaike information criterion.
[a] $p < 0.05$.
[b] $p < 0.01$.
[c] $p < 0.001$.

excluding participants who 'failed' the rationality test indicates no change to the conclusions (Appendix Table 3).

3.5. Relative importance of attributes across priming conditions and pandemic severity

Across the four conditions, each 10% increase in influenza CFR had a greater effect on vaccination choice compared with each 10% increase in Infection Probability (Table 3). Based on the preference weights shown in Table 3, the influence ratio (relative importance) of influenza CFR (each 10% increase) to Vaccine Safety ("uncertain" relative to "mild") was 1.44 (1.30/0.90) for Control participants, 2.68 (1.10/0.41) for influenza risk-primed participants, 1.76 (0.95/0.52) for vaccine risk-primed participants and 1.46 (0.70/0.48) for non-specific risk-primed participants. This indicates that disease risk priming may have increased the importance of disease-relevant attributes relative to that of vaccine-attributes when individuals made trade-off in decision making. The relative importance of attributes in determining vaccination preference during a mild (2009 A/H1N1-like) pandemic and a severe (A/H5N1-like) pandemic across the four conditions is shown in Fig. 1. It shows that regardless of pandemic severity, Vaccine Efficacy was more important than external cues (Doctors' advice and Community Vaccination Coverage) in determining vaccination choice but a CVCR increasing from 5% to 60% was more important than Vaccine Safety in determining vaccination choice across the

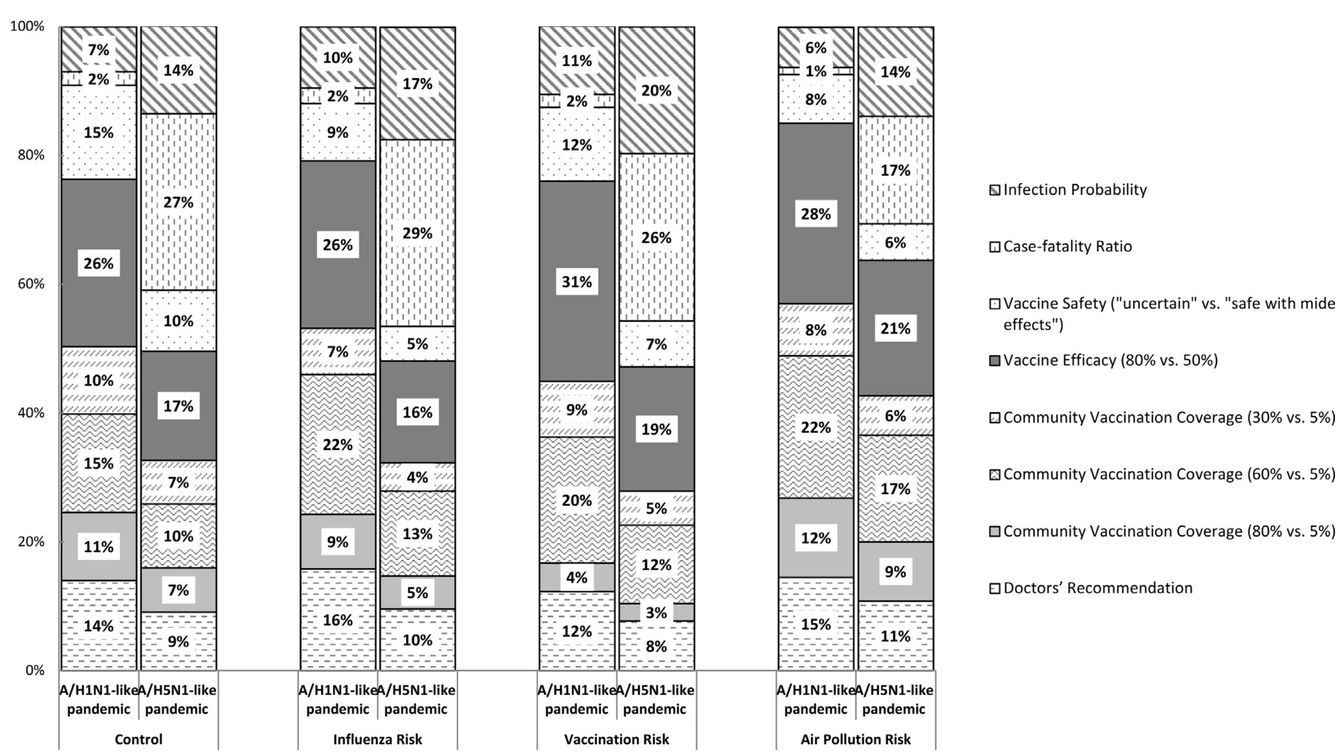

Fig. 1. The relative importance of attributes for vaccination preference across the four priming conditions by level of pandemic risk.

four conditions. Across all four conditions, Doctors' Recommendation appeared to compensate the negative effects of "uncertain" Vaccine Safety in this community. Fig. 1 also showed that compared with the total contribution of disease-relevant attributes (Infection Probability and CFR), the total contribution of vaccine-relevant attributes (Vaccine Efficacy and Vaccine Safety) were higher for a mild pandemic but was lower for a severe pandemic, in determining vaccination choice across all four conditions. When CFR was as high as 20%, it became the most important attribute for determining vaccination choice compared with other attributes included in the experiment.

4. Discussion

Overall, the findings were consistent with our hypothesis that increases in influenza Infection Probability, CFR, Vaccine efficacy and Vaccine Safety, Doctors' encouragement and decrease in Vaccination Cost were significantly associated with increased probability of choosing vaccination. The significant effects of disease and vaccine characteristics and external cues on vaccination choice indicate that vaccination decision making follows the dual-process models rather than the pure normative behavioural models. While a growing number of studies used DCE to examine the relative importance of key determinants on vaccination preference [43,44], our study was the first report of how probability of choosing vaccination changes as CVCR increased in a DCE. The result is also consistent with our hypothesis that regardless of priming conditions, probability of choosing vaccination increases with greater CVCR to reach an apogee at an uptake rate of 60%, indicating that crowd-sourcing "imitate-the-majority" strategy is used as a heuristic for vaccination decisions [27]. However, thereafter, vaccination probability declines as CVCR further increases to 80%, indicating a growing preference for individuals to avoid vaccination when community uptake is sufficiently high to generate herd immunity, and where the likelihood of personal exposure to infection falls significantly. This suggests the use of the "risk-riding" strategy in vaccination decision [26,29]. This is interesting because even in the absence of a formal explanation of herd immunity there may be an intuitive grasp of the community benefits of mass immunity and chances to minimize risk to self may be maximized.

4.1. Relative importance of attributes in determining vaccination choice

Consistent with one previous study [43], each 10% increase in influenza CFR was far more influential on vaccination choice than was an equivalent increase in Infection Probability regardless of priming conditions, suggesting that individuals value consequences much more than risk probability. Although the "value-expectancy models" propose that both probability and severity of outcomes are important for determining personal behavioural choice, these models do not differentiate the impacts of high-probability and low-dread outcomes versus low-probability and high-dread outcomes on individual behaviours whereas the latter is usually more impactful on public perceptions and behaviours [57]. This is a limitation of the "value-expectancy models". Across the four conditions, Vaccine Efficacy had a greater effect on vaccination choice compared with social cues. This is not consistent with our hypothesis, suggesting that individual decision making for vaccination is dominantly guided by a deliberative and reasoned assessment of the behavioural benefits rather than heavily relying on external cues. However, in consistent with our hypotheses, regardless of priming conditions, both a CVCR increasing from 5% to 60% and Doctors' Recommendation could compensate the negative effect of "uncertain" vaccine safety on vaccination choice. This suggests that when vaccine safety is uncertain, external cues such as others' vaccination uptake and doctors' recommendation can be used as the proxies to validate vaccine safety or how to behave is appropriate (or socially acceptable). Consistent with our hypothesis, for a relatively mild pandemic similar to the 2009 influenza A/H1N1 pandemic, disease risk is less important than vaccination safety and efficacy in determining vaccination choice. This means that during a mild pandemic, it is difficult to encourage vaccination uptake among the general public when the safety of a new vaccine is usually perceived to be uncertain due to insufficient time and practice to validate its safety [21]. Likewise, for an A/H5N1-like severe pandemic, disease risk can override the effect of 'uncertain' vaccine safety, becoming dominant among all attributes included in this experiment in influencing vaccination choice. This may reflect the influence of a affective process triggered by the high probability and dreadful risk on behavioural response [58].

4.2. Priming effect

Compared with Control participants, the relative importance of influenza risk (Infection probability and CFR) to Vaccine Safety was greater for participants primed by influenza risk, suggesting potential priming effects on information processing and subsequently behavioural choice [30]. However, effects of disease-relevant attributes were not significantly interacted with the priming condition, suggesting that instead of increasing participants' attention to disease risk and thereby its effect on vaccination choice, the disease risk priming may work to affect the tradeoff between disease and vaccine risk. For participants primed by vaccine risk, the effect of vaccine risk on vaccination choice or its effect relative to that of influenza risk was not greater than was that for Control participants. However, for participants primed by vaccine risk, a CVCR increasing from 5% to 80% was not significantly associated with probability of choosing vaccination while the same association was greater and significantly positive for Control participants. This suggests that although the vaccine risk priming cannot increase the effect of vaccine risk on vaccination choice by increasing participants' attention to vaccine risk, it can significantly change participants' decision-making process for vaccination decision. That is, to avoid vaccination risk by free riding on herd immunity when perceiving that probability of personal infection declines significantly, reflecting more deliberate thoughts when trading off risk between disease and vaccine. The positive interaction effect between non-specific (air pollution) risk priming and a CVCR of 80% in determining vaccination choice was unexpected. This interaction effect indicates that compared with Control participants, a CVCR increasing from 5% to 80% had significantly greater and positive effects on vaccination choice for participants primed by non-specific risk. The non-specific risk priming video was rated to be significantly more threatening, more negative in affective valence and more affectively arousing than other three videos though reported risk-specific worry was not higher in the non-specific risk priming group. It is possible that participants primed by the non-specific risk had more implicit concern over their health risk which increases their tendency to follow the normative behaviour (what the majority do in the community) to reduce their concern or gain some sense of control over risk. However, this explanation needs future experimental testing. Overall, these findings suggest that risk-specific priming seems not to directly increase the importance of specific attributes on vaccination decision but affect the decision-making strategies such as increasing the relative weight of specific risk attributes when individuals trade off risk between the disease and the intervention. This is possibly because that the implicit risk-specific affect inducted by the priming intervention may interact with the conscious and deliberative process in decision making for vaccination. However, since this study did not assess participants' implicit affect after the intervention, despite more affectively loaded videos were used as the priming interventions, this explanation awaits testing in future studies.

4.3. Study limitations

Our study has several limitations. First, participants were quasi randomly allocated to either the control or the risk-priming conditions based on time of study entry, resulting in marginally unbalanced sample profiles for different conditions. Second, as this study excluded subjects who had ever taken any influenza vaccination since adulthood, the findings may not be applicable to those who have a history of influenza vaccination though this group accounts for only around 20% of the adult population. Third, despite all participants completed the DCE in a relative quite environment to ensure that videos could be clearly viewed and heard, potential distraction of external noise was difficult to eliminate, and may have influenced the results. Furthermore, the context of the experiment was still different from an actual pandemic when explicit emotion (e.g. anxiety) about the disease may override the cognitive decision making process.

5. Conclusion and implication

First, the findings highlight the importance of high vaccine efficacy in determining vaccination choice, in particular for influenza with relatively low probability of severe consequences. This may be an important reason for the generally low uptake rates of vaccination against seasonal influenza in many countries [8,10,59], because for many seasonal influenza vaccine efficacy was perceived to be low due to variability of age-specific vaccine efficacy, whether the vaccine strains can match the dominant circulating virus strains, and misunderstanding that the vaccine could protect against all influenza-like illnesses including common cold [60]. Therefore, to encourage vaccination against seasonal influenza, it is important to highlight the social benefits of high vaccination uptake rates for the community, disclose experts' accuracy in predicting the dominant circulating influenza virus strains and clarifying that the vaccine mainly protects illnesses caused by influenza viruses. Second, during a pandemic with a relatively low CFR such as the 2009 influenza A/H1N1 pandemic, even vaccine efficacy was perceived to be high, feeling uncertain about the safety of a new vaccine could become a major barrier for encouraging vaccination uptake [10,21]. Experts' risk estimate is usually based on the high probability of infection and thereby a substantial disease burden for the whole population, the indirect social costs due to societal responses to the disease, and the predicted severer consequences of the second wave of the pandemic [61]. However, the general public mainly perceived disease risk based on their experience and the dreadfulness of the diseases (probability of fatal consequence) in the first wave of the pandemic, which diverges from the experts' risk estimate. This means that in a pandemic with high probability of infection but low probability of fatal consequence, communicating more information about disease risk may not be useful to encouraging vaccination uptake. Instead, addressing public concerns over vaccine safety by involving doctors and early vaccine takers to validate the vaccine safety may be more effective to encourage vaccination uptake. Third, for a pandemic with relatively severe consequences specifically if the CFR is 20% or greater, messages about the dreadful outcomes will become dominantly important to shape vaccination choice. Forth, the findings about the influence of increasing CVCR on individual vaccination choice well integrated findings from other observational and modelling studies [26–29], suggesting the strong influence of social cues on vaccination uptake. Such influence suggests that while reporting community vaccination uptake statistics showing increasing vaccination coverage should help to encourage public vaccination uptake during a vaccination campaign, above 60% coverage such communication should be progressively minimized. This is possibly one reason for the increased parental vaccine hesitancy regarding their children's vaccinations of which coverage rates are already high [62]. Finally, our study indicates that brief exposure to information about influenza/vaccine risk seems not effective for increasing the effect of influenza/vaccine risk on vaccination choice. However, it may change the relative weight of specific risk when individuals trade off risk between disease and intervention. Such priming effects should be differentiated from the effects of exposure to intensive media coverage about disease risk and vaccine risk debates over a period during a real pandemic on individual vaccination choice. Instead, it is more relevant to the effect of a brief discussion with doctors about influenza/vaccine risk or exposure to a short message (video or leaflet) about disease/vaccine risk during health care visit, which may affect individuals' real-time vaccination choice by changing their deliberative decision-making process.

Funding

This work was supported by the Health Medical Research Funding, Food and Health Bureau, Government of Hong Kong [grant number 14130942, 2015].

Declaration of Competing Interest

The authors declare no conflict of interest.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2019.05.072.

References

[1] Lafond KE, Nair H, Rasooly MH, Valente F, Booy R, Rahman M, et al. Global role and burden of influenza in pediatric respiratory hospitalizations, 1982–2012: A systematic analysis. PLoS Med 2016;13:e1001977. https://doi.org/10.1371/journal.pmed.1001977.

[2] World Health Organization. Influenza 2019. Available from: https://www.who.int/influenza/en/ [accessed 25 April 2019].

[3] Taubenberger JK, Morens DM. 1918 Influenza: the mother of all pandemics. Emerg Infect Dis 2006;12:15–22.

[4] Garske T, Legrand J, Donnelly CA, Ward H, Cauchemez S, Fraser C, et al. Assessing the severity of the novel influenza A/H1N1 pandemic. BMJ 2009;339:b2840.

[5] Li FC, Choi BC, Sly T, Pak AW. Finding the real case-fatality rate of H5N1 avian influenza. J Epidemiol Commun Health 2008;62:555–9. https://doi.org/10.1136/jech.2007.064030.

[6] Jefferson T, Di Pietrantonj C, Rivetti A, Bawazeer GA, Al-Ansary LA, Ferroni E. Vaccines for preventing influenza in healthy adults. Cochrane Database Syst Rev 2010:CD001269. https://doi.org/10.1002/14651858.CD001269.pub4.

[7] Asllani A, Ettkin L. A generic simulation model to manage a vaccination program. J Med Syst 2011;35:1465–75. https://doi.org/10.1007/s10916-009-9423-1.

[8] Lu PJ, Srivastav A, Santibanez TA, Christopher Stringer M, Bostwick M, Dever JA, et al. Knowledge of influenza vaccination recommendation and early vaccination uptake during the 2015–16 season among adults aged ≥18years – United States. Vaccine 2017;35:4346–54. https://doi.org/10.1016/j.vaccine.2017.06.074.

[9] Center for Health Protection Hong Kong. Vaccination subsidy scheme - general public 2018. Available from: https://www.chp.gov.hk/en/features/46107.html [accessed 9 April 2019].

[10] Liao Q, Cowling BJ, Lam WW, Fielding R. Factors affecting intention to receive and self-reported receipt of 2009 pandemic (H1N1) vaccine in Hong Kong: a longitudinal study. PLoS ONE 2011;6:e17713. https://doi.org/10.1371/journal.pone.0017713.

[11] Liao Q, Lam WW, Cowling BJ, Fielding R. Psychosocial influences on parental decision-making regarding vaccination against seasonal influenza for young

children in Hong Kong: a longitudinal study, 2012–2013. IntJ Behav Med. 2016;23:621–34. https://doi.org/10.1007/s12529-016-9551-1.
[12] von Neumann J, Morgenstern O. Theory of games and economic behavior. Princeton: Princeton University Press; 1944.
[13] Edwards W. Behavioral decision theory. Ann Rev Psychol 1961;12:473–98. https://doi.org/10.1146/annurev.ps.12.020161.002353.
[14] Conner M, Norman P. Predicting health behavior. Berkshire: Open University Press; 2005.
[15] Kahneman D, Tversky A. Prospect theory: an analysis of decision under risk. Econometrica 1979;47:263–92.
[16] Webb TL, Sheeran P. Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. Psychol Bull 2006;132:249–68.
[17] Houlihan S. Dual-process models of health-related behaviour and cognition: a review of theory. Public Health 2018;156:52–9. https://doi.org/10.1016/j.puhe.2017.11.002.
[18] Slovic P, Finucane ML, Peters E, MacGregor DG. Risk as analysis and risk as feelings: some thoughts about affect, reason, risk, and rationality. Risk Anal 2004;24:311–22.
[19] Kahneman D. Thinking, fast and slow. Macmillan; 2011.
[20] Kan T, Zhang J. Factors influencing seasonal influenza vaccination behaviour among elderly people: a systematic review. Public Health 2018;156:67–78. https://doi.org/10.1016/j.puhe.2017.12.007.
[21] Bish A, Yardley L, Nicoll A, Michie S. Factors associated with uptake of vaccination against pandemic influenza: a systematic review. Vaccine 2011;29:6472–84. https://doi.org/10.1016/j.vaccine.2011.06.107.
[22] Fu LY, Zimet GD, Latkin CA, Joseph JG. Associations of trust and healthcare provider advice with HPV vaccine acceptance among African American parents. Vaccine 2017;35:802–7. https://doi.org/10.1016/j.vaccine.2016.12.045.
[23] Lu PJ, Srivastav A, Amaya A, Dever JA, Roycroft J, Kurtz MS, et al. Association of provider recommendation and offer and influenza vaccination among adults aged >/=18years - United States. Vaccine 2018;36:890–8. https://doi.org/10.1016/j.vaccine.2017.12.016.
[24] Renner B, Reuter T. Predicting vaccination using numerical and affective risk perceptions: the case of A/H1N1 influenza. Vaccine 2012;30:7019–26. https://doi.org/10.1016/j.vaccine.2012.09.064.
[25] Liao Q, Wong WS, Fielding R. How do anticipated worry and regret predict seasonal influenza vaccination uptake among Chinese adults? Vaccine 2013;31:4084–90. https://doi.org/10.1016/j.vaccine.2013.07.009.
[26] Bhattacharyya S, Bauch CT. "Wait and see" vaccinating behaviour during a pandemic: a game theoretic analysis. Vaccine 2011;29:5519–25. https://doi.org/10.1016/j.vaccine.2011.05.028.
[27] Parker AM, Vardavas R, Marcum CS, Gidengil CA. Conscious consideration of herd immunity in influenza vaccination decisions. Am J Prev Med 2013;45:118–21. https://doi.org/10.1016/j.amepre.2013.02.016.
[28] Wang LD, Lam WW, Wu JT, Liao Q, Fielding R. Chinese immigrant parents' vaccination decision making for children: a qualitative analysis. BMC Public Health 2014;14:133. https://doi.org/10.1186/1471-2458-14-133.
[29] Fu F, Rosenbloom DI, Wang L, Nowak MA. Imitation dynamics of vaccination behaviour on social networks. Proc Biol Sci 2011;278:42–9. https://doi.org/10.1098/rspb.2010.1107.
[30] Bargh JA, Morsella E. The unconscious mind. Perspect Psychol Sci 2008;3:73–9. https://doi.org/10.1111/j.1745-6916.2008.00064.x.
[31] Papies EK. Health goal priming as a situated intervention tool: how to benefit from nonconscious motivational routes to health behaviour. Health Psychol Rev 2016:1–17. https://doi.org/10.1080/17437199.2016.1183506.
[32] Barsalou LW. Simulation, situated conceptualization, and prediction. Philosoph Trans Roy Soc B: Biol Sci 2009;364:1281–9. https://doi.org/10.1098/rstb.2008.0319.
[33] King D, Vlaev I, Everett-Thomas R, Fitzpatrick M, Darzi A, Birnbach DJ. "Priming" hand hygiene compliance in clinical environments. Health Psychol 2016;35:96–101. https://doi.org/10.1037/hea0000239.
[34] Hollands GJ, Marteau TM. Pairing images of unhealthy and healthy foods with images of negative and positive health consequences: Impact on attitudes and food choice. Health Psychol 2016;35:847–51. https://doi.org/10.1037/hea0000293.
[35] Papies EK, Stroebe W, Aarts H. The allure of forbidden food: On the role of attention in self-regulation. J Exp Soc Psychol 2008;44:1283–92. https://doi.org/10.1016/j.jesp.2008.04.008.
[36] Husemann S, Fischer F. Content analysis of press coverage during the H1N1 influenza pandemic in Germany 2009–2010. BMC Public Health 2015;15:386. https://doi.org/10.1186/s12889-015-1742-1.
[37] Reintjes R, Das E, Klemm C, Richardus JH, Kessler V, Ahmad A. "Pandemic Public Health Paradox": Time series analysis of the 2009/10 influenza A/H1N1 epidemiology, media attention, risk perception and public reactions in 5 European countries. PLoS ONE 2016;11:e0151258. https://doi.org/10.1371/journal.pone.0151258.
[38] Falagas ME, Kiriaze IJ. Reaction to the threat of influenza pandemic: the mass media and the public. Crit Care 2006;10:408. https://doi.org/10.1186/cc4910.
[39] Dunn AG, Leask J, Zhou X, Mandl KD, Coiera E. Associations between exposure to and expression of negative opinions about human papillomavirus vaccines on social media: an observational study. J Med Internet Res 2015;17:. https://doi.org/10.2196/jmir.4343e144.
[40] Mason BW, Donnelly PD. Impact of a local newspaper campaign on the uptake of the measles mumps and rubella vaccine. J Epidemiol Community Health 2000;54:473–4. https://doi.org/10.1136/jech.54.6.473.
[41] Betsch C, Renkewitz F, Betsch T, Ulshofer C. The influence of vaccine-critical websites on perceiving vaccination risks. J Health Psychol 2010;15:446–55. https://doi.org/10.1177/1359105309353647.
[42] Ryan M, Gerard K, Amaya-Amaya M. SpringLink. Using discrete choice experiments to value health and health care. Dordrecht: Springer Netherlands; 2008.
[43] Eilers R, de Melker HE, Veldwijk J, Krabbe PFM. Vaccine preferences and acceptance of older adults. Vaccine 2017;35:2823–30. https://doi.org/10.1016/j.vaccine.2017.04.014.
[44] de Bekker-Grob EW, Veldwijk J, Jonker M, Donkers B, Huisman J, Buis S, et al. The impact of vaccination and patient characteristics on influenza vaccination uptake of elderly people: A discrete choice experiment. Vaccine 2018;36:1467–76. https://doi.org/10.1016/j.vaccine.2018.01.054.
[45] Determann D, Korfage IJ, Fagerlin A, Steyerberg EW, Bliemer MC, Voeten HA, et al. Public preferences for vaccination programmes during pandemics caused by pathogens transmitted through respiratory droplets - a discrete choice experiment in four European countries, 2013. Euro Surveill 2016;21. https://doi.org/10.2807/1560-7917.ES.2016.21.22.30247.
[46] Determann D, Korfage IJ, Lambooij MS, Bliemer M, Richardus JH, Steyerberg EW, et al. Acceptance of vaccinations in pandemic outbreaks: a discrete choice experiment. PLoS ONE 2014;9:e102505. https://doi.org/10.1371/journal.pone.0102505.
[47] Gaillet-Torrent M, Sulmont-Rosse C, Issanchou S, Chabanet C, Chambaron S. Impact of a non-attentively perceived odour on subsequent food choices. Appetite 2014;76:17–22. https://doi.org/10.1016/j.appet.2014.01.009.
[48] LeDoux JE. Emotion: Clues from the brain. Annu Rev Psychol 1995;46:209–35.
[49] Bar-Haim Y, Lamy D, Pergamin L, Bakermans-Kranenburg MJ, van IMH. Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. Psychol Bull 2007;133:1–24. https://doi.org/10.1037/0033-2909.133.1.1.
[50] Mathews A, Sebastian S. Suppression of emotional stroop effects by fear-arousal. Cogn Emot 1993;7:517–30. https://doi.org/10.1080/02699939308409203.
[51] Witte K, Allen M. A meta-analysis of fear appeals: implications for effective public health campaigns. Health Educ Behav 2000;27:591–615. https://doi.org/10.1177/109019810002700506.
[52] Maurer J, Harris KM, Parker A, Lurie N. Does receipt of seasonal influenza vaccine predict intention to receive novel H1N1 vaccine: evidence from a nationally representative survey of U.S. adults. Vaccine 2009;27:5732–4. https://doi.org/10.1016/j.vaccine.2009.07.080.
[53] Bradley MM, Lang PJ. Measuring emotion: the self-assessment manikin and the semantic differential. J Behav Ther Exp Psychiatry 1994;25:49–59.
[54] Hauber AB, Gonzalez JM, Groothuis-Oudshoorn CG, Prior T, Marshall DA, Cunningham C, et al. Statistical methods for the analysis of discrete choice experiments: a report of the ISPOR conjoint analysis good research practices task force. Value Health 2016;19:300–15. https://doi.org/10.1016/j.jval.2016.04.004.
[55] Hong Kong Census and Statistics Department. 2016 Population By-census 2016. Available from: https://www.censtatd.gov.hk/hkstat/sub/so459.jsp [accessed 5 September 2018].
[56] Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale, NJ: Erlbaum; 1988.
[57] Merz B, Elmer F, Thieken AH. Significance of "high probability/low damage" versus "low probability/high damage" flood events. Nat Hazards Earth Syst Sci 2009;9:1033–46. https://doi.org/10.5194/nhess-9-1033-2009.
[58] Loewenstein GF, Weber EU, Hsee CK, Welch N. Risk as feelings. Psychol Bull 2001;127:267–86.
[59] Wu S, Su J, Yang P, Zhang H, Li H, Chu Y, et al. Factors associated with the uptake of seasonal influenza vaccination in older and younger adults: a large, population-based survey in Beijing, China. BMJ Open 2017;7:e017459. https://doi.org/10.1136/bmjopen-2017-017459.
[60] Schmid P, Rauber D, Betsch C, Lidolt G, Denker M-L. Barriers of influenza vaccination intention and behavior – a systematic review of influenza vaccine hesitancy, 2005–2016. PLoS ONE 2017;12:e0170550. https://doi.org/10.1371/journal.pone.0170550.
[61] Slovic P. Perception of risk. Science 1987;236:280–5.
[62] Edwards KM, Hackell JM. Committee on infectious diseases TCOP, ambulatory M. Countering vaccine hesitancy. Pediatrics 2016;138. https://doi.org/10.1542/peds.2016-2146.