

# What helps people make values-congruent medical decisions?

## Eleven strategies tested across six studies

**AUTHORS:** Holly O. Witteman, PhD\*, Anne-Sophie Julien, MSc, Ruth Ndjaboue, PhD, Nicole L. Exe, MPH, Valerie C. Kahn, MPH, Angela Fagerlin, PhD, Brian J. Zikmund-Fisher, PhD

**HOW:** Department of Family and Emergency Medicine, Faculty of Medicine, Laval University, Quebec City, Quebec, Canada; Office of Education and Professional Development, Faculty of Medicine, Laval University, Quebec City, Quebec, Canada; Research Centre of the CHU de Québec, Quebec City, Quebec, Canada; Centre de recherche sur les soins et les services de première ligne de l'Université Laval, Quebec City, Quebec, Canada  
ORCID: 0000-0003-4192-0682

**ASJ:** Department of Mathematics and Statistics, Université Laval, Quebec City, Quebec, Canada  
ORCID: 0000-0002-5578-1399

**RN:** Office of Education and Professional Development, Faculty of Medicine, Laval University, Quebec City, Quebec, Canada; Research Centre of the CHU de Québec, Quebec City, Quebec, Canada  
ORCID:

**NLE:** Center for Bioethics and Social Sciences in Medicine, University of Michigan, Ann Arbor, Michigan, USA

**VCK:** Center for Bioethics and Social Sciences in Medicine, University of Michigan, Ann Arbor, Michigan, USA

**AF:** Professor & Chair, Department of Population Health Sciences, Salt Lake City, Utah, USA  
Research Scientist, Salt Lake City VA Informatics Decision-Enhancement and Analytic Sciences (IDEAS 2.0) Center for Innovation, Salt Lake City, Utah, USA

**BJZ:** Department of Health Behavior and Health Education, University of Michigan, Ann Arbor, Michigan, USA; Department of Internal Medicine, University of Michigan, Ann Arbor, Michigan, USA; Center for Bioethics and Social Sciences in Medicine, University of Michigan, Ann Arbor, Michigan, USA  
ORCID: 0000-0002-1637-4176

\*Corresponding author: Holly O. Witteman, 1050 avenue de la Médecine, Pavillon Ferdinand-Vandry, Université Laval, Québec City, Québec, G1V 0A6, Canada, telephone: 418.656.2131 x3981, fax: 418.656.2465, email: [holly.witteman@fmed.ulaval.ca](mailto:holly.witteman@fmed.ulaval.ca)

**Keywords:** values clarification; decision quality

**Running title:** What works to support values-congruent decisions

# Abstract

**Background:** High-quality health decisions are often defined as those that are both evidence-informed and values-congruent. A values-congruent decision aligns with what matters to those most affected by the decision. Values clarification methods are intended to support values-congruent decisions but their effects on values congruence are rarely evaluated.

**Methods:** We tested eleven strategies, including the three most commonly-used values clarification methods, across six between-subjects online randomized experiments in demographically-diverse US populations ( $n_1=1346$ ,  $n_2=456$ ,  $n_3=840$ ,  $n_4=1178$ ,  $n_5=841$ ,  $n_6=2033$ ) in the same hypothetical decision. Our primary outcome was values congruence. Decisional conflict was a secondary outcome in studies 3 through 6.

**Results:** Two commonly-used values clarification methods (pros and cons, rating scales) reduced decisional conflict but did not encourage values-congruent decisions. Strategies using mathematical models to show participants which option aligned with what mattered to them encouraged values-congruent decisions and reduced decisional conflict when assessed.

**Limitations:** A hypothetical decision was necessary for ethical reasons, as we believed some strategies may harm decision quality. Later studies used more outcomes and covariates. Results may not generalize outside US-based adults with online access. We assumed validity and stability of values during the brief experiments.

**Conclusions:** Failing to explicitly support the process of values clarification leads to increased proportions of values-disgruent decisions. Methods representing over half of values clarification methods commonly in use failed to encourage values-congruent decisions. Methods that use models to explicitly show people how options align with their values hold more promise for helping people make decisions aligned with what matters to them. Decisional conflict, while arguably an important outcome in and of itself, is not an appropriate proxy for values congruence.

# Main Text

## Introduction

Health decisions are often defined as being of high quality when they are both evidence-informed and values-congruent.[1–3] Considerable literature is available to help us achieve the first part of that goal. Although communicating evidence remains a complex task and best practices are not always followed, we have a great deal of guidance about how to best communicate the potential benefits and harms of different medical options in understandable ways.[4–9]

In contrast, there is far less guidance about how to ensure decisions are values-congruent (or values-concordant[10]), meaning the decision aligns with what matters to the people most affected by the decision. We know very little about the effects of common interventions like patient decision aids on this outcome, as the effects of interventions on values congruence are far less often reported than their effects on knowledge.[11] Additionally, though explicit values clarification methods as a whole have been shown to somewhat encourage values-congruent decisions[11,12], explicit methods are extremely diverse[13], few of these methods have been tested at all, and fewer still have been evaluated on whether or not they encourage values-congruent decisions.[14] Among the few methods for which effects on values congruence have been evaluated, results have been mixed.[15–18]

In this series of six studies testing eleven strategies, we aimed to identify values clarification methods and other strategies that help people make values-congruent decisions. As a secondary objective, we aimed to assess strategies' effects on decisional conflict.[19] In these studies and in this paper, we apply definitions from previous medical decision making literature referring to *values* as, “the extent to which decision attributes matter to an individual,” while the related term *preferences* refers to, “an individual’s inclination toward or away from a given decision option.”[13] These definitions distinguish between values for health states or health outcomes and preferences for a given treatment option.

## Methods

### Study designs

Each of the six studies was an online experiment in a diverse population of adults living in the United States. In each experiment, we randomized participants to receive no intervention or one or two of eleven strategies. Each study was designed as an independent study. Studies 3-6 used a common control group for efficiency.

Studies used an adapted version of a previously-published decision-making scenario.[20] In all studies, we first asked participants to answer a question to establish which of two health states they value more highly. Specifically, we explained what a colostomy is, then asked, if they had

to choose, would they rather have a colostomy or die? Participants assigned to control arms were then immediately asked them to choose between two options. Participants assigned to intervention arms were offered one or two of the eleven strategies we were testing, then asked to choose between the same two options. The choice between two options asked participants to imagine having been diagnosed with colon cancer and facing a choice between two hypothetical surgeries. The first surgery offered an 80% of a complete cure, a 16% chance of death, and a 4% chance of cure with a colostomy. The second surgery offered an 80% of a complete cure and a 20% chance of death. This means that the two surgeries differed only in that one had a 4% chance of colostomy while the other had a 4% additional chance of death. The first surgery is therefore congruent with valuing colostomy over death; the second, with valuing death over colostomy.

In studies 3-6, we randomized the order of presentation of colostomy and death. Approximately half of each sample chose between colostomy and death. The other half of each sample chose between death and colostomy. The surgeries were presented in the matching order, meaning that if colostomy was presented first in the assessment of values, the surgery with colostomy was presented first in the assessment of choice.

## Participants

Participants were adults 18 years or older living in the United States and able to participate in an English-language online survey. We excluded participants who answered the full survey (including the studies described here and other, cross-randomized studies) in under 5 minutes, as this suggested they may not have been paying attention to the tasks. We applied no other inclusion or exclusion criteria.

## Recruitment

We recruited participants through Survey Sampling International (studies 1 and 2) or Amazon's Mechanical Turk (studies 3-6). In all cases, study participants received a small lottery or monetary incentive for participating. In studies 1 and 2, we use stratified sampling to approximate major gender, racial and ethnic proportions in the United States.

## Data collection

We administered the studies using Qualtrics (Provo, UT).

## Independent variables

Independent variables in each study were the presence or absence of one or two interventions.

## Interventions

### Intervention development

Studies one through five used interventions developed within our research group. Study six used an intervention whose development was led by the first author (HW) using methods of user-centered design,[21–26] beginning with paper prototypes and proceeding through seven cycles of iterative design with 23 prototypical users in total.

#### Study 1

In study 1, we tested two strategies. Strategy 1a was a visual prompt highlighting the key difference between the two surgeries. The visual prompt (Figure 1) drew upon Gestalt principles of perception,[27,28] particularly the principle of proximity, to explicitly highlight the key difference between the two surgeries. We tested this visual prompt both with and without a reflective prompt (strategy 1b) asking participants prior to making their choice, “Please think about the differences between Surgery 1 and 2. With Surgery 1, patients have a higher chance of dying; with Surgery 2, patients have a higher chance of having a colostomy. In your opinion, which surgery is the better choice?”

#### Study 2

In study 2, we tested two strategies. Strategy 2a was a static visual feature explicitly informing participants of the best fit for them (Figure 2). Strategy 2b was a static visual feature providing participants with feedback after their choice if their decision didn’t align with their values (Figure 3). Both visual features used a box around the choice that aligned with the person’s stated values and a saturation fade of 80% on the disgruent choice, thus rendering the values-congruent option as slightly more vivid on the screen. Strategies 2a and 2b are versions of ‘math model-based’ values clarification methods. Such methods require a mathematical model to determine the relationship between stated values and options. This group was the second most common set of methods used in a systematic review of values clarification methods.[13]

#### Study 3

Strategy 3 consisted of an emotional self-assessment. Participants were asked to indicate, on 7-point Likert scales, their self-assessments of the following three questions: (1) “How much do you like making this decision?” with response options from “Not at all” to “Very much”; (2) “How distressing is it to make this decision?” with response options from “Not at all distressing” to “Very distressing”; and (3) “How disgusting or upsetting do you find the possible side effect of Surgery 2 (colostomy)?” with response options from “Not at all disgusting or upsetting” to “Very disgusting or upsetting.”

#### Study 4

Study 4 tested two strategies. Strategy 4a was a prompt to make an intuitive decision. The specific wording of the prompt was, “On the next few pages, you will be given some information about a medical situation and asked to make a decision about treatment. As you make this

decision, go with your emotions or gut-feeling. Make your choice quickly and follow your instincts. Use your hunches and intuition.” Strategy 4b was a prompt to make a deliberative decision and a deliberative exercise. The specific wording of the prompt was, “On the next few pages, you will be given some information about a medical situation and asked to make a decision about treatment. As you make this decision, try to be rational and intellectual. Make your choice slowly, in a thoughtful way. Use your powers of logic and reason.” Participants were then asked to answer 4 groups of questions in small open text boxes: (1) What are the pros of Surgery 1? Which pros are important to you, and why? (2) What are the cons of Surgery 1? Which cons are important to you, and why? (3) What are the pros of Surgery 2? Which pros are important to you, and why? (4) What are the cons of Surgery 2? Which cons are important to you, and why? Strategy 4b is a version of ‘pros and cons’ values clarification methods, the most common set of methods used in a systematic review of values clarification methods.[13]

### Study 5

Strategy 5 consisted of narratives about adaptation and questions intended to encourage participants to deliberate about their own capacity to adapt to living with a colostomy. Following these narratives, we asked participants to answer the questions, “Have you ever had to get used to a life change that was unexpected and difficult?” with response options “yes” or “no,” and “If, by chance, you ever needed to have a colostomy, do you think you would eventually get used to it?” with response options “yes” or “no.”

### Study 6

Study 6 tested three strategies in a nested 2x2 factorial experiment. Strategy 6a consisted of dynamic web sliders representing a prototypical values clarification method of rating attributes (Figure 4). In strategy 6b, we added the first factor of our factorial experiment. We made the tradeoffs in the decision explicit by constraining the dynamic web sliders. When the participant moved one slider to the right, the other slider automatically moved the equivalent distance to the left. In strategy 6c, we used the second factor of our factorial experiment to make the implications of stated values explicit. We added a dynamic visual feature of vertical bars explicitly informing participants of the best fit for them, using a simple 1:1 linear model to determine this. Specifically, when the participant moved one slider three quarters of the way to the right, the associated vertical bar moved three quarters of the way up. The fourth arm of this experiment used the features of 6b and 6c together. Figure 4 shows a brief video demonstrating these four conditions. Strategy 6a is a version of an unconstrained ‘rating scales’ values clarification methods, the third most common set of methods used in a systematic review of values clarification methods, while 6b and 6c use the interface of rating methods together with a ‘model-based’ back end.[13]

### Covariates

In all studies, we included self-reported age, sex (male or female), racial and ethnic groups with sufficient subsample sizes to be included in the model (specifically, people who self-reported as Black, Hispanic, and/or White), health status, and subjective numeracy[29,30] as covariates. In studies 3-6 we also included preference for intuition and preference for deliberation.[31]

## Primary outcome

Our primary outcome was values congruence. We defined a values-congruent decision as one in which the choice of surgery aligned with the participant's previous indication of valuing colostomy over death, or vice versa. In other words, if a participant indicated that they valued colostomy over death, a values-congruent decision meant they chose the surgery with a 4% chance of colostomy over the surgery with an additional 4% chance of death.

## Secondary outcomes

In four of the six studies, we also assessed decisional conflict as a secondary outcome, using nine Decisional Conflict Scale[32] items applicable to a hypothetical scenario (Cronbach alpha=0.92).

## Statistical analyses

For our primary outcome of values congruence, we conducted multivariable logistic regressions. In study 2, because Strategy 2b involved providing feedback if the participant made a values-disgruent choice and thus was conditional on participants' initial choice, we tested separate models for people who had and had not received a recommendation and used an intercept-only model to estimate the proportion of participants making a values-congruent final choice. For our secondary outcome, we had initially intended to conduct linear regressions on Decisional Conflict; however, assumptions of the models were not respected in several of the studies. We therefore elected to dichotomize the measure at 37.5, a threshold previously recommended as the threshold below which people do not feel greatly conflicted and are likely to follow through on their decision.[19] We then conducted multivariable logistic regressions. In all of these analyses, we included all listed covariates.

After conducting analyses of each individual study, we also analysed each strategy against no strategy to enable an overall view of which strategies might be most promising. In these analyses, we included covariates that were common to all studies.

All statistical analyses were conducted in R, version 3.2.4.[33]

## Results

We briefly present results for each study below, followed by overall results summarizing the effects of each strategy. We provide full details of regression results of each study in Appendix 1, and sex-stratified statistics in Appendix 2 in accordance with Sex and Gender Equity in Research (SAGER) guidelines.[34]

## Participant characteristics

Participant characteristics for all studies are shown in Tables 1 and 2.

Table 1 about here

Table 2 about here

## Study 1

Neither a visual prompt alone (strategy 1a) nor a visual prompt together with a reflective prompt (strategies 1a + 1b) increased values congruence. In the control condition, 319 participants (72%) made a values-congruent choice. Among participants randomized to strategy 1a, 313 (68%) made a values-congruent choice. Among participants randomized to strategies 1a + 1b, 329 (74%) made a values-congruent choice. These proportions were not statistically significantly different from each other ( $p=0.17$ ).

## Study 2

Providing a recommendation about which option fit best with the participants' stated values before (strategy 2a) or after (strategy 2b) the initial decision increased values congruence. The overall numbers of people making values-congruent choices were 158 (73%) in the control condition without feedback, 196 (82%) in the 'best fit for you' condition prior to feedback (strategy 2a), 176 (81%) in the control condition with no recommendation prior to the initial choice but with feedback provided if and only if the person made a values-disgruent initial choice (strategy 2b), and 211 (89%) when the person received both the 'best fit for you' information and feedback if they made a values-disgruent initial choice (strategies 2a + 2b).

## Study 3

Conducting an emotional self-assessment (strategy 3) influenced neither values congruence of decisions nor decisional conflict. Three hundred and thirty participants (78%) in the control condition made a values-congruent decision while 321 (77%) in the strategy 3 condition did the same. One hundred and seventy-one participants (41%) in the control condition had low decisional conflict while 178 (43%) in the strategy 3 condition had the same.

## Study 4

Neither encouraging people to make an intuitive decision (Strategy 4a) nor encouraging people to deliberate and providing a deliberation exercise in which they wrote about the pros and cons of each option (Strategy 4b) led to greater values congruence, but the latter led to more people having lower decisional conflict. Three hundred and sixteen participants (78%) randomized to Strategy 4a made a values-congruent choice, as did 276 (79%) of those randomized to Strategy 4b (versus 78% in the control condition). Of those randomized to Strategy 4a, 192 (47%) had low decisional conflict, as did 182 (52%) of those randomized to Strategy 4b (versus 41% in the control condition).

## Study 5

Offering narratives about adaptation to colostomy and asking people to reflect on their own capacity for adaptation (Strategy 5) did not influence values congruence but did increase the

number of participants reporting lower decisional conflict. Three hundred and forty-four participants (82%) made a values-congruent choice (versus 78% in the control condition) and 202 (48%) had lower decisional conflict (versus 41% in the control condition).

## Study 6

A prototypical 'rating' values clarification method (Strategy 6a) offered no benefit in terms of values congruence compared to the control condition, but did result in reduced decisional conflict. Two hundred and seventy-eight participants (77%) randomized to Strategy 6a made a values-congruent choice (versus 78% in the control condition) and 193 (53%) had low decisional conflict (versus 41% in the control condition).

Compared to Strategy 6a, making participants engage with tradeoffs in a decision (Strategy 6b) and showing how options align with stated values (Strategy 6c) resulted in greater values congruence. Three hundred and twenty-seven (83%) participants randomized to Strategy 6b alone made a values-congruent choice, as did 361 (82%) of those randomized to Strategy 6c alone, and 354 (86%) of those randomized to Strategies 6b and 6c combined. Compared to Strategy 6a, there were no differences in decisional conflict. One hundred and eighty-nine (48%), 222 (51%) and 212 (51%) of participants randomized to Strategies 6b, 6c, and 6b+6c, respectively, reported low decisional conflict.

## Overall results

Table 3 shows an overview of results for each strategy or combination of strategies compared to no strategy as a control, with 95% confidence intervals describing the increase or decrease in values congruence and low decisional conflict for each strategy or set of strategies. Overall, strategies 2a, 2b, 6b and 6c were the most promising for encouraging values-congruent decisions, particularly 2a and 2b together, and 6b and 6c together. Strategies 6b and 6c together encouraged values-congruent choices while also offering benefits in the form of encouraging low decisional conflict. The effects of strategies 2a and 2b on decisional conflict were not measured.

Table 3 about here

## Discussion

In this series of studies, we aimed to determine how to support people in making values-congruent health decisions; that is, decisions that align with what they value. Our results led us to three main observations. First, strategies that represent over half of published values clarification methods showed no indication of supporting values-congruent decisions. These methods were no better than doing nothing, suggesting that a large proportion of values clarification methods currently in use could be improved. Second, strategies can reduce decisional conflict with or without encouraging values congruence, and vice versa. This indicates that measuring decision conflict is insufficient if we wish to know whether an intervention encourages values congruence. Third and finally, strategies exist to both encourage

values-congruent decisions and reduce decisional conflict. Such methods explicitly show relationships between what matters to someone and their options. We expand on these observations below.

First, common values clarification methods such as asking people to consider pros and cons or to rate the importance of each decision attribute showed no benefits in terms of encouraging values congruence. These methods encompass over half of published values clarification exercises.[13] This suggests that a large proportion of current shared decision making initiatives and patient decision support tools may be failing to support values-congruent decisions to the greatest extent possible. Health decisions are often difficult. They involve making sense of complicated information, often under real or perceived pressure while worried or afraid. And yet, even if sense is achieved, understanding the information is not enough. People then have to integrate medical evidence with what matters to them, which typically requires grappling with high-stakes tradeoffs. Offering no support (for example, simply eliciting preferences) or offering minimal support (for example, pros and cons lists, rating scales) as people undertake this process is likely insufficient.

Second, deliberative strategies such as asking people to consider and reflect on the pros and cons of each option, to rate the importance of each decision attribute, or to reflect on their capacity for adaptation showed reductions in decisional conflict but no benefits in terms of values congruence. These results support previously expressed concern about the uncritical use of lower decisional conflict as a metric of higher decision quality. While it is arguably a good thing for people to feel less conflicted about a decision, previous authors have suggested that lower decisional conflict may indicate that the person making the decision has not truly engaged with the difficult tradeoffs inherent in many decisions.[35,36] Our findings support and extend this more nuanced view. Authors and users of different versions of the Decisional Conflict Scale have clearly shown that it measures perceived—not actual—values clarity and congruence.[32,37] Given the normative social message that decisions should be made deliberatively, the Decisional Conflict Scale may be measuring the extent to which people feel they made a decision the right way, rather than the extent to which they made the right decision for them. This suggestion aligns with other findings by Scherer and colleagues that people may feel more confident about objectively poorer decisions when they make them in a deliberative way.[38] Decisional conflict and its subscales should not be used as a measure of how well a decision is aligned with what matters to the person or people making it.

Third and finally, the most effective methods we found to support values-congruent decisions were methods that explicitly showed people how what matters to them aligns or fails to align with their options. This could take the form of a dynamic, interactive interface showing the fit between values and options along with the tradeoffs inherent in the decision (strategies 6b + 6c) or a static display shown before indicating a choice (strategy 2a) or only after making a disrugent choice (strategy 2b). The static displays require a simpler decision whose outcomes can be depicted in a single icon array, whereas the dynamic, interactive interface can be applied in more complex decision contexts. The static displays also explicitly used the term, “recommended for you,” and did not explain why one option was recommended, whereas

strategy 6c avoided the term “recommended” and transparently showed the relationship between expressed values and options.

Both static (2a, 2b) and dynamic (6c) strategies require mathematical models of the relationships between what matters to the person making the decision and their available options. Making trade-offs explicit (6b) also requires specification of how decision attributes relate to each other mathematically. Other values clarification methods not tested in the studies described here have similar features and may therefore offer similar benefits; for example, many methods of multicriteria decision analysis.[39] Communication frameworks or patterns in which the health professional explicitly maps patient values onto medical options[40,41] may also offer similar benefits. Such communication frameworks and patterns do not require formal mathematical models but do require health professionals to have mental models of relationships between what matters to patients and the options available to them.

In addition to encouraging values-congruent decisions, dynamically showing the fit between values and options and the tradeoffs inherent in the decision also reduced decisional conflict. Because we did not assess this outcome when testing static displays, we cannot compare these strategies on this outcome. It is possible that showing the fit between values and options in a static way would also reduce decisional conflict. It is also possible that providing people with feedback that their indicated preference is not aligned with their previously stated values could increase decisional conflict by suggesting their initial decision is of lower quality.

The dynamic, interactive interface was also used in a subsequent study to support real decisions about children’s influenza vaccination. Parents randomly assigned to receive the interface reported higher intentions to vaccinate their children after using the interface, especially parents who had not previously vaccinated their children against influenza. However, the primary outcome in that study was not values congruence and a high rate of loss to follow-up 6 months later made it difficult to assess final decisions.[42] Eiring and colleagues[43] also used a similar user-centered design process as ours to develop an intervention for a decision with more than two options. Their research team independently arrived at an interface similar to ours with more sliders and dynamic bars, with multicriteria decision analysis determining the relationship between input sliders and output bars. This interface has not yet been evaluated for effectiveness.

Thus, while it is too early to make definitive claims about an optimal values clarification method for encouraging values-congruent decisions in all contexts, evidence thus far suggests that promising methods are those in which users explore and indicate what matters to them; for example, using design elements like sliders, while receiving dynamic feedback about how their available options align with these expressed values.

## Code Availability

We have deposited in Zenodo[44] the current version of the software[45] for the interactive interface that combines Strategies 6b + 6c. The software is written in JavaScript and is freely available under the GNU General Public License, version 2 (GPLv2). We also offer a

dynamically editable version of the interface hosted on the first author's laboratory website for those who would like to explore or use the interface in English[46] or French[47]. This interface allows people to explore how they feel about decision attributes and see the relationship between their expressions of value and the options available to them. The interface and the software may be freely used and adapted according to the GPLv2 license, with citation of this article in publications.

## Limitations

Our study has four main limitations. First, the scenarios and decisions in these studies were hypothetical. This was a necessary feature because we had reason to believe that control conditions and strategies representing commonly-used values clarification methods may cause participants to make decisions of lower quality. It would have been unethical to conduct experiments of this nature in real medical decisions. Second, because this was a series of studies in which we gradually refined our goals, our methods shifted along the way. Although all six studies were aimed at understanding how to support values congruent decisions, we included additional outcome measures and covariates in studies 3 through 6. Third, all studies were conducted in English with participants recruited from US-based online panels. It is possible that people who do not speak English, who belong to cultures with views of autonomy that differ from common views in the United States, or who do not participate in online surveys may have different responses to these strategies. Fourth and finally, our definition and measure of values congruence assumes that participants' expressions of whether they would prefer to die or have a colostomy were both valid and stable during the experiments. We assumed validity even though people may feel differently about outcomes like colostomy and death under conditions of uncertainty because ultimately, people do not experience a 4% chance, they either experience the outcome or not. In other words, we defined a values-congruent decision as one that aligns with a person's valuation of one health state over another, not how the person respond to the possibilities of such states. We assumed stability because preference reversal[48] is a well-known phenomenon in decisions like these[49,50] and we believed it was therefore more likely to occur in a brief experiment than a true re-evaluation of values. However, this remains an assumption. We did not test stability by asking participants to restate which outcome they valued over the other.

## Conclusions

A significant proportion of current patient decision support may not be actively helping patients make decisions that align with what matters to them. Values clarification methods that make up over half of published methods may reduce decisional conflict without increasing values congruence.

Evaluations of decision quality should not rely on measures of decisional conflict to assess values congruence. While decisional conflict is an important construct in and of itself, it is not an adequate proxy measure of the extent to which a decision is aligned with what matters to the person making the decision.

To help people make values-congruent health decisions while also reducing decisional conflict, the most promising methods are those that support people in explicitly engaging with trade-offs and that explicitly show people how well or poorly different options align with what matters to them. Open access software is available for researchers and others who wish to use this method. Further research will determine how promising methods compare to each other and how to optimally support decisions with more than two options.

# Figures

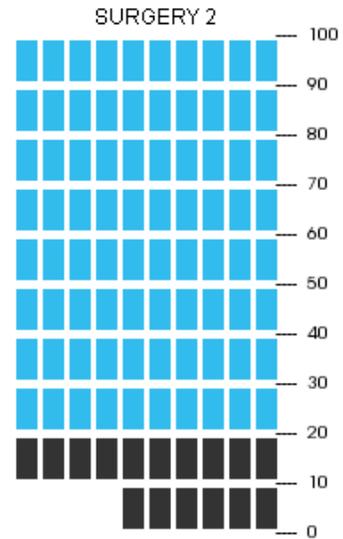
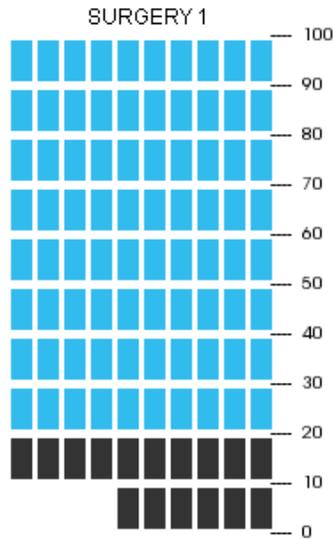
Figure 1. Visual prompt using Gestalt principles (Strategy 1a)

## SAME

For every 100 people who have either Surgery 1 or Surgery 2, this shows how many people have the **same results**.

 80 are cured (80%)

 16 die (16%)



## DIFFERENT

For every 100 people who have either Surgery 1 or Surgery 2, this shows how many people have **different results**.

  
4 more people die (4%)

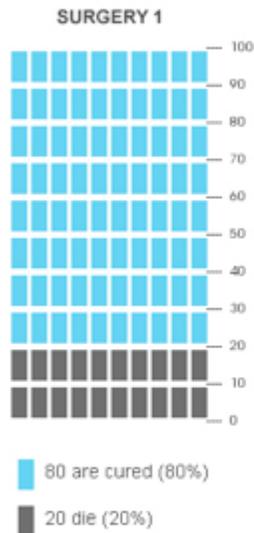
I would choose Surgery 1

  
4 people are cured, but must have a colostomy (4%)

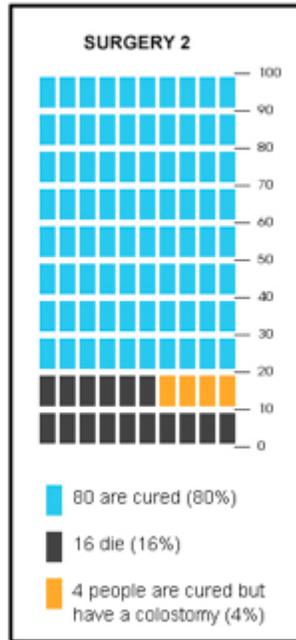
I would choose Surgery 2

Figure 2. 'Recommended for you' static image (Strategy 2a)

### Recommended for You

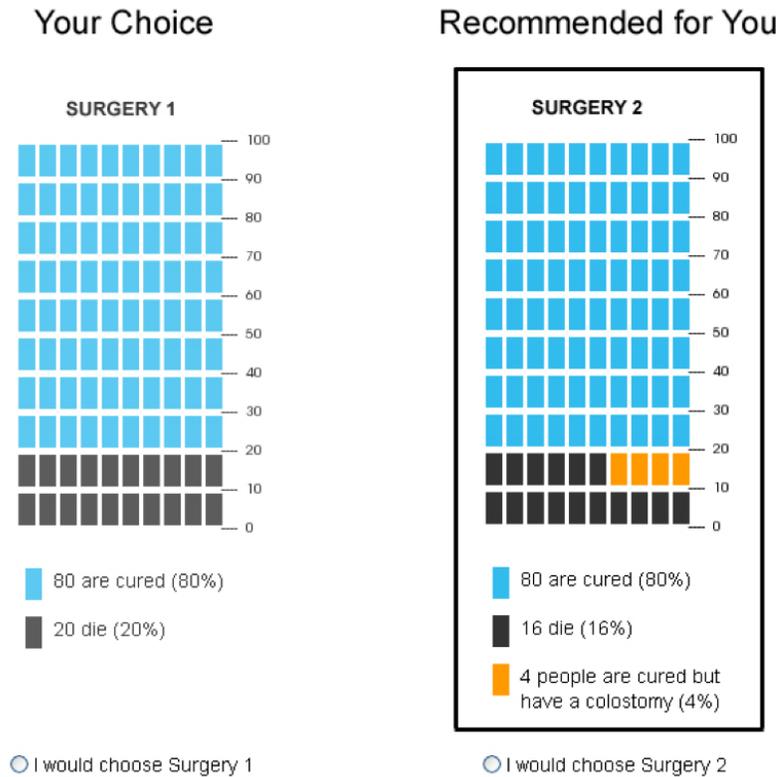


I would choose Surgery 1



I would choose Surgery 2

Figure 3. Static feedback image provided in the event of a values-disgruent choice (Strategy 2b)



Accompanying text: Earlier, you told us that you would rather have a colostomy than die. Based on that answer, the best choice for you between these two surgeries would have been Surgery 2. It fits your preferences best because it has a higher chance of colostomy compared to death. However, you chose Surgery 1 instead. There might be reasons why you decided to choose Surgery 1, but we wanted to give you this information, and let you change your choice if you want.

Figure 4. [Slider interface demonstration \(Strategies 6a, 6b, 6c, 6b + 6c\)](#)

The hyperlink is to a .gif file hosted at:

[http://wlab.fmed.ulaval.ca/wp-content/uploads/CUCD\\_demo6abc\\_cropped.gif](http://wlab.fmed.ulaval.ca/wp-content/uploads/CUCD_demo6abc_cropped.gif)

# Tables

Table 1. Participant Characteristics for Studies 1 and 2

	Study 1 (n = 1346)			Study 2 (n = 456)		
Characteristic	Control (n = 442)	Strategy 1a (n = 459)	Strategies 1a + 1b (n = 445)	Control (n = 217)	Strategy 2a (n = 239)	Strategy 2b (n = 102)**
Age in years: Median (IQR*)	50 (38-60)	50 (38-59)	49 (37-58)	51 (40-60)	50 (40-58)	51 (38-60)
Male: N (%)	232 (52)	230 (50)	217 (49)	99 (47)	130 (56)	41 (42)
Black: N (%)	53 (12)	77 (17)	61 (14)	39 (18)	37 (15)	18 (18)
Hispanic: N (%)	52 (12)	56 (12)	59 (13)	32 (15)	35 (15)	17 (17)
White: N (%)	346 (78)	346 (75)	340 (76)	151 (70)	172 (72)	67 (66)
Self-Reported Health***: Median (IQR)	2 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)
Subjective Numeracy****: Median (IQR)	35 (29-42)	36 (29-40)	36 (29-41)	34 (28-40)	34 (28-40)	33 (29-40)
<b>Cronbach's Alpha for Measures Used</b>						

Subjective Numeracy Scale	0.87	0.86
---------------------------	------	------

\*IQR = interquartile range. IQR is presented as quartile 1 to quartile 3.

\*\*Participants within the study as a whole were randomized 1:1 to receive strategy 2b only if their initial choice was disruent. Therefore, this subsample represents the participants of those randomized to this condition who initially made a disruent choice.

\*\*\*Self-Reported Health was measured on a 5-point Likert scale where 1 indicates "Excellent", 2 indicates "Very Good", 3 indicates "Good", 4 indicates "Fair", and 5 indicates "Poor".

\*\*\*\*Subjective Numeracy was measured on a scale from 8 to 48, where higher numbers indicate higher subjective numeracy.

Table 2. Participant Characteristics for Studies 3, 4, 5, and 6

<b>Variable</b>	<b>Control (n=422)</b>	<b>Strategy 3 (n=418)</b>	<b>Strategy 4a (n=406)</b>	<b>Strategy 4b (n=350)</b>	<b>Strategy 5 (n=419)</b>	<b>Strategy 6a (n=363)</b>	<b>Strategy 6b (n=395)</b>	<b>Strategy 6c (n=440)</b>	<b>Strategies 6b + 6c (n=413)</b>
Age in years: Median (IQR)	27 (22-39)	27 (22-37)	28 (22-35)	26 (22-35)	28 (22-37)	27 (22-37)	26 (22-36)	27 (22-36)	27 (22-39)
Male: N (%)	185 (44)	183 (44)	185 (46)	177 (51)	194 (46)	178 (49)	186 (47)	194 (44)	193 (47)
Black: N (%)	23 (6)	26 (6)	33 (8)	34 (10)	28 (7)	29 (8)	36 (9)	43 (10)	36 (9)
Hispanic: N (%)	28 (7)	41 (10)	30 (7)	24 (7)	26 (6)	18 (5)	23 (6)	26 (6)	24 (6)
White: N (%)	355 (84)	354 (85)	337 (83)	285 (81)	364 (87)	298 (82)	314 (79)	356 (81)	350 (85)
Self-Reported Health*: Median (IQR)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)
Subjective Numeracy**: Median (IQR)	39 (33-42)	38 (32-43)	38 (32-43)	38 (32-43)	38 (32-43)	38 (33-43)	38 (32-43)	38 (32-42)	38 (33-43)
Preference for Deliberation***: Median (Q1-Q3)	3.9 (3.7-4.2)	3.9 (3.4-4.3)	3.9 (3.7-4.3)	4.0 (3.7-4.3)	4.0 (3.6-4.3)	3.9 (3.6-4.3)	3.9 (3.6-4.2)	3.9 (3.6-4.3)	3.9 (3.6-4.3)
Preference for Intuition***: Median (Q1-Q3)	3.3 (2.9-3.7)	3.3 (2.9-3.7)	3.3 (2.9-3.8)	3.3 (3.0-3.8)	3.3 (3.0-3.7)	3.3 (3.0-3.8)	3.3 (3.0-3.7)	3.2 (2.9-3.7)	3.4 (3.0-3.8)

<b>Cronbach's Alphas</b>									
Decisional Conflict	0.92	0.90	0.91	0.91	0.92	0.91	0.92	0.90	0.92
Subjective Numeracy	0.86	0.88	0.86	0.84	0.87	0.84	0.84	0.83	0.84
Preference for Deliberation	0.79	0.80	0.74	0.77	0.81	0.81	0.78	0.80	0.82
Preference for Intuition	0.76	0.77	0.79	0.78	0.76	0.76	0.74	0.79	0.77

\*Self-Reported Health was measured on a 5-point Likert scale where 1 indicates "Excellent", 2 indicates "Very Good", 3 indicates "Good", 4 indicates "Fair", and 5 indicates "Poor".

\*\*Subjective Numeracy was measured on a scale from 8 to 48, where higher numbers indicate higher subjective numeracy.

\*\*\*Preference for Deliberation and Intuition were both measured on scales from 1 to 5 by taking the mean across 9 items, each measured on a scale from 1 to 5. Higher numbers indicate stronger preference for that mode of decision making.

Table 3. Overview of Strategies and Results

Strategies	Descriptions and key characteristics of strategies	Values clarification method <sup>13</sup>	Values congruence		Low decisional conflict	
			Difference (95% CI)*	Odds Ratio (95% CI)	Difference (95% CI)**	Odds Ratio (95% CI)
1a (visual prompt)	Visual prompt based on Gestalt principles of perception (Figure 1)	n/a	-3.8% (-9.8;2.2)	0.83 (0.62-1.11)	--	--
1a + 1b (visual prompt + reflective prompt)	Visual prompt based on Gestalt principles of perception, followed by reflective prompt ("Which surgery is the better choice?")	n/a	+1.7% (-4.2;7.6)	1.09 (0.81-1.47)	--	--
2a (recommendation)	Recommendation of which option fits best ("Recommended for You") (Figure 2)	Math Model-Based	+7.9% (0.1;15.7)	1.59 (1.01-2.54)	--	--
2a + 2b (recommendation + feedback)	Recommendation of which option fits best given to all + feedback given to those whose initial choice was values-disgruent (Figure 3)	Math Model-Based	+14.9% (7.6;22.2)	2.80 (1.69-4.75)	--	--
3 (emotional self-assessment)	Emotional self assessment via three questions (e.g., "How distressing is it to make this decision?")	n/a	-1.6% (-7.3;4.1)	0.91 (0.66-1.27)	+2.2% (-4.7;9.1)	1.10 (0.82-1.46)
4a (prompt to use intuition)	Prompt to make an intuitive decision ("As you make this decision, go with your emotions or gut-feeling. Make your choice quickly and follow your instincts. Use your hunches and intuition.")	n/a	-0.1% (-5.8;5.6)	0.99 (0.71-1.38)	+6.1% (-0.9;13.1)	1.28 (0.96-1.71)

4b (prompt to use reason plus writing exercise)	Prompt to make a deliberative decision (“As you make this decision, try to be rational and intellectual. Make your choice slowly, in a thoughtful way,”) and deliberative exercise writing and reflecting on the pros and cons of each option.	Pros and Cons	+0.9% (-4.9;6.7)	1.05 (0.74-1.50)	+10.6% (3.3;17.9)	1.54 (1.14-2.07)
5 (narratives and reflection about adaptation)	Narratives about adaptation and self-assessment about capacity to adapt using 2 questions (e.g., “Have you ever had to get used to a life change that was unexpected and difficult?”)	n/a	+3.7% (-1.7;9.1)	1.26 (0.90-1.79)	+7.7% (0.7;14.7)	1.37 (1.03-1.82)
6a (rating attributes)	Interactive interface using two independent sliders, one for each decisional attribute. (Figure 4)	Rating Scales	-1.6% (-7.5;4.3)	0.91 (0.65-1.28)	+13.5% (6.3;20.7)	1.73 (1.29-2.32)
6b (explicit tradeoffs)	Interactive interface using two dependent sliders, one for each decisional attribute. When the user moves one slider to the left by one unit the other slider automatically moves to the right by one unit. (Figure 4)	Math Model-Based	+4.7% (-0.7;10.1)	1.36 (0.96-1.93)	+8.0% (1.0;15.0)	1.39 (1.04-1.85)
6c (explicit implications)	Interactive interface using two independent sliders, one for each decisional attribute, and vertical bars showing fit with options. When the user moves one slider to the right by one unit the associated vertical bar automatically moves up by one unit. (Figure 4)	Math Model-Based	+4.0% (-1.3;9.3)	1.29 (0.92-1.81)	+11.2 % (4.4;18)	1.57 (1.19-2.08)
6b + 6c (explicit tradeoffs and implications)	Interactive interface using two dependent sliders and associated vertical bars. When the user moves one slider to the left by one unit the other slider automatically moves to the right by one unit and the associated vertical bars move up and down by one unit, respectively. (Figure 4)	Math Model-Based	+7.5% (2.3;12.7)	1.67 (1.17-2.41)	+10.5% (3.6;17.4)	1.53 (1.16-2.04)

CI = confidence interval

\* Differences in values congruence are reported as the differences in the percentage of participants selecting the values-congruent option when randomly assigned to the strategy(ies) compared to participants who were randomly assigned no intervention. Higher numbers indicate the strategy(ies) encouraged values

congruence compared to control. Analyses were adjusted for variables: age, male, White, Black, Hispanic, health demographics, and subjective numeracy, as these were the covariates that were available in all studies. These analyses were conducted in addition to the analyses for each study (see Appendix 1) to allow comparison across studies.

\*\* Differences in low decisional conflict are reported as the differences in the percentage of participants with low decisional conflict ( $\leq 37.5$ ) when randomly assigned to the strategy(ies) compared to participants who were randomly assigned no intervention. Higher numbers indicate the strategy(ies) encouraged acceptably low levels of decisional conflict compared to control. Analyses were adjusted for the same covariates as those in analyses of values congruence and also for Preference for Deliberation and Preference for Intuition. These analyses were conducted in addition to the primary analyses for each study (see Appendix 1) to allow comparison across studies.

# DECLARATIONS

## Abbreviations

None

## Ethics Approval, Consent to Participate and Consent for Publication

The studies presented here were deemed exempt from ethical review as anonymous online studies by the Institutional Review Board of the University of Michigan.

## Availability of Data and Materials

Open source JavaScript for the slider interface (strategies 6b + 6c) is available in Zenodo[44] and GitHub[45] under the GNU General Public License, version 2 (GPLv2). A dynamically editable version of the interface hosted on the first author's laboratory website for those who would like to explore or use the interface in English[46] or French[47].

## Competing Interests

None.

## Funding

The studies presented were made possible by the National Institutes of Health (NIH) R01 CA087595 (PI Ubel) and P50 CA101451 (PI Strecher). Further code development and analyses were funded by the Canadian Institutes of Health Research FDN-148426 (PI Wittman). Neither the NIH nor the CIHR had any role in determining the study design, the plans for data collection or analysis, the decision to publish, nor the preparation of this manuscript. HOW receives salary support from a Research Scholar Junior 2 Career Award by the Fonds de Recherche du Québec—Santé. During these studies, BJZF received salary support from the American Cancer Society.

## Authors' Contributions

Contributions are reported according to the CRediT taxonomy.[51] Conceptualization: HOW, AA (see Acknowledgments). Methodology: HOW, AA, LS, AF, BJZF. Software: MD, MTB (see Acknowledgments). Formal Analysis: ASJ. Investigation: HOW, NE, BJZF. Resources: HOW, BJZF. Data Curation: HOW, ASJ, NE. Writing – Original Draft: HOW, ASJ, RN. Writing – Review & Editing: HOW, ASJ, RN, NE, VK, LS, AF, BJZF. Funding Acquisition: HOW, AF,

BJZF. HOW had full access to all the data in the study and had final responsibility for the decision to submit for publication.

## Acknowledgements

Studies 3 and 4 tested interventions proposed for study by Andrea Angott, PhD. The authors gratefully acknowledge the contributions of Mark Dickson and Martin Tremblay-Breault to programming. We thank all study participants for helping us identify ways to improve decision making in health care.

# References

1. Marteau TM, Dormandy E, Michie S. A measure of informed choice. *Health Expect.* 2001 Jun;4(2):99–108.
2. Légaré F, Witteman HO. Shared Decision Making: Examining Key Elements And Barriers To Adoption Into Routine Clinical Practice. *Health Aff.* 2013 Feb 1;32(2):276–84.
3. Hoffmann TC, Montori VM, Del Mar C. The connection between evidence-based medicine and shared decision making. *JAMA.* 2014 Oct 1;312(13):1295–6.
4. Stableford S, Mettger W. Plain language: a strategic response to the health literacy challenge. *J Public Health Policy.* 2007;28(1):71–93.
5. Fagerlin A, Zikmund-Fisher BJ, Ubel PA. Helping patients decide: ten steps to better risk communication. *J Natl Cancer Inst.* 2011 Oct 5;103(19):1436–43.
6. Garcia-Retamero R, Okan Y, Cokely ET. Using visual aids to improve communication of risks about health: a review. *ScientificWorldJournal.* 2012 May 2;2012:562637.
7. Trevena LJ, Zikmund-Fisher BJ, Edwards A, Gaissmaier W, Galesic M, Han PKJ, King J, Lawson ML, Linder SK, Lipkus I, Ozanne E, Peters E, Timmermans D, Woloshin S. Presenting quantitative information about decision outcomes: a risk communication primer for patient decision aid developers. *BMC Med Inform Decis Mak.* 2013 Nov 29;13 Suppl 2:S7.
8. Okan Y, Garcia-Retamero R, Cokely ET, Maldonado A. Improving risk understanding across ability levels: Encouraging active processing with dynamic icon arrays. *J Exp Psychol Appl.* 2015 Jun;21(2):178–94.
9. Garcia-Retamero R, Cokely ET. Designing Visual Aids That Promote Risk Literacy: A Systematic Review of Health Research and Evidence-Based Design Heuristics. *Hum Factors.* 2017 Jun;59(4):582–627.
10. Winn K, Ozanne E, Sepucha K. Measuring patient-centered care: An updated systematic review of how studies define and report concordance between patients' preferences and medical treatments. *Patient Educ Couns.* 2015 Jul;98(7):811–21.
11. Stacey D, Légaré F, Lewis K, Barry MJ, Bennett CL, Eden KB, Holmes-Rovner M, Llewellyn-Thomas H, Lyddiatt A, Thomson R, Trevena L. Decision aids for people facing health treatment or screening decisions. *Cochrane Database Syst Rev.* 2017 Apr 12;4:CD001431.
12. Munro S, Stacey D, Lewis KB, Bansback N. Choosing treatment and screening options congruent with values: Do decision aids help? Sub-analysis of a systematic review. *Patient Educ Couns.* 2016 Apr;99(4):491–500.
13. Witteman HO, Scherer LD, Gavaruzzi T, Pieterse AH, Fuhrel-Forbis A, Chipenda Dansokho S, Exe N, Kahn VC, Feldman-Stewart D, Col NF, Turgeon AF, Fagerlin A. Design Features of Explicit Values Clarification Methods: A Systematic Review. *Med Decis Making.* 2016 May;36(4):453–71.

14. Witteman HO, Gavaruzzi T, Scherer LD, Pieterse AH, Fuhrel-Forbis A, Chipenda Dansokho S, Exe N, Kahn VC, Feldman-Stewart D, Col NF, Turgeon AF, Fagerlin A. Effects of Design Features of Explicit Values Clarification Methods: A Systematic Review. *Med Decis Making*. 2016 Aug;36(6):760–76.
15. O'Connor AM, Wells GA, Tugwell P, Laupacis A, Elmslie T, Drake E. The effects of an “explicit” values clarification exercise in a woman’s decision aid regarding postmenopausal hormone therapy. *Health Expect*. 1999 Mar;2(1):21–32.
16. Matheis-Kraft C, Roberto KA. Influence of a values discussion on congruence between elderly women and their families on critical health care decisions. *J Women Aging*. 1997;9(4):5–22.
17. Montgomery AA, Fahey T, Peters TJ. A factorial randomised controlled trial of decision analysis and an information video plus leaflet for newly diagnosed hypertensive patients. *Br J Gen Pract*. 2003 Jun;53(491):446–53.
18. Sheridan SL, Griffith JM, Behrend L, Gizlice Z, Jianwen Cai, Pignone MP. Effect of adding a values clarification exercise to a decision aid on heart disease prevention: a randomized trial. *Med Decis Making*. 2010 Jul;30(4):E28–39.
19. O'Connor AM. User Manual – Decisional Conflict Scale [Internet]. University of Ottawa; 2010. Available from: [https://decisionaid.ohri.ca/docs/develop/User\\_Manuals/UM\\_Decisional\\_Conflict.pdf](https://decisionaid.ohri.ca/docs/develop/User_Manuals/UM_Decisional_Conflict.pdf)
20. Amsterlaw J, Zikmund-Fisher B, Fagerlin A, Ubel PA. Can avoidance of complications lead to biased healthcare decisions? *Judgm Decis Mak*. 2006;1(1):64.
21. Abras C, Maloney-Krichmar D, Preece J. User-centered design. *Encyclopedia of Human-Computer Interaction*. 2004;37(4):445–56.
22. Norman DA. *The Design of Everyday Things*. Basic Books; 2002. 384 p.
23. ISO DIS. 9241-210: 2010. Ergonomics of human system interaction-Part 210: Human-centred design for interactive systems. International Standardization Organization (ISO). Switzerland.; 2009.
24. Gould JD, Lewis C. Designing for Usability: Key Principles and What Designers Think. *Commun ACM*. 1985 Mar;28(3):300–11.
25. Nielsen J. The usability engineering life cycle. *Computer* . 1992 Mar;25(3):12–22.
26. Mao BJ-Y, Vredenburg K, Smith PW, Carey T. The state of user-centered design practice. *Commun ACM*. 2005;48(3):105–9.
27. Han S, Humphreys GW, Chen L. Uniform connectedness and classical Gestalt principles of perceptual grouping. *Percept Psychophys*. 1999 May;61(4):661–74.
28. Graham LM. Gestalt Laws of Perception. *Design Principles and Practices: An International Journal—Annual Review*. 2009;3(4):385–94.
29. Fagerlin A, Zikmund-Fisher BJ, Ubel PA, Jankovic A, Derry HA, Smith DM. Measuring numeracy without a math test: development of the Subjective Numeracy Scale. *Med Decis*

- Making. 2007 Sep;27(5):672–80.
30. Zikmund-Fisher BJ, Smith DM, Ubel PA, Fagerlin A. Validation of the Subjective Numeracy Scale: effects of low numeracy on comprehension of risk communications and utility elicitation. *Med Decis Making*. 2007 Sep;27(5):663–71.
  31. Betsch C. Preference for Intuition and Deliberation (PID): An inventory for assessing affect- and cognition-based decision-making. *Zeitschrift für Differentielle und Diagnostische Psychologie*. 2004;25:179–97.
  32. O'Connor AM. Validation of a decisional conflict scale. *Med Decis Making*. 1995 Jan;15(1):25–30.
  33. R Development Core Team. R: A language and environment for statistical computing [Internet]. Vienna, Austria: R Foundation for Statistical Computing; 2017. Available from: <https://www.R-project.org/>
  34. Heidari S, Babor TF, De Castro P, Tort S, Curno M. Sex and Gender Equity in Research: rationale for the SAGER guidelines and recommended use. *Research Integrity and Peer Review*. 2016 May 3;1(1):2.
  35. Nelson WL, Han PKJ, Fagerlin A, Stefanek M, Ubel PA. Rethinking the objectives of decision aids: a call for conceptual clarity. *Med Decis Making*. 2007 Sep;27(5):609–18.
  36. Vickers AJ. Decisional Conflict, Regret, and the Burden of Rational Decision Making. *Med Decis Making*. 2017 Jan;37(1):3–5.
  37. Linder SK, Swank PR, Vernon SW, Mullen PD, Morgan RO, Volk RJ. Validity of a low literacy version of the Decisional Conflict Scale. *Patient Educ Couns*. 2011 Dec;85(3):521–4.
  38. Scherer LD, de Vries M, Zikmund-Fisher BJ, Witteman HO, Fagerlin A. Trust in deliberation: The consequences of deliberative decision strategies for medical decisions. *Health Psychol*. 2015 Nov;34(11):1090–9.
  39. Thokala P, Devlin N, Marsh K, Baltussen R, Boysen M, Kalo Z, Longrenn T, Mussen F, Peacock S, Watkins J, Ijzerman M. Multiple Criteria Decision Analysis for Health Care Decision Making--An Introduction: Report 1 of the ISPOR MCDA Emerging Good Practices Task Force. *Value Health*. 2016 Jan;19(1):1–13.
  40. Childers JW, Back AL, Tulskey JA, Arnold RM. REMAP: A Framework for Goals of Care Conversations. *J Oncol Pract*. 2017 Oct;13(10):e844–50.
  41. Lang E, Bell NR, Dickinson JA, Grad R, Kasperavicius D, Moore AE, Singh H, Thériault G, Wilson BJ, Stacey D. Eliciting patient values and preferences to inform shared decision making in preventive screening. *Can Fam Physician*. 2018 Jan;64(1):28–31.
  42. Witteman HO, Chipenda Dansokho S, Exe N, Dupuis A, Provencher T, Zikmund-Fisher BJ. Risk Communication, Values Clarification, and Vaccination Decisions. *Risk Anal*. 2015 Oct;35(10):1801–19.
  43. Eiring Ø, Nytrøen K, Kienlin S, Khodambashi S, Nylenna M. The development and feasibility of a personal health-optimization system for people with bipolar disorder. *BMC*

Med Inform Decis Mak. 2017 Jul 10;17(1):102.

44. Zenodo [Internet]. [cited 2018 Oct 26]. Available from: <https://zenodo.org/>
45. WittemanLab. vcm: Values clarification methods [Internet]. Github; [cited 2018 Oct 25]. Available from: <https://github.com/WittemanLab/vcm>
46. WittemanLab. Values Clarification Methods [Internet]. [cited 2018 Oct 25]. Available from: <http://wlab.fmed.ulaval.ca/projects/vcm/en/>
47. WittemanLab. Méthodes de clarification des valeurs [Internet]. [cited 2018 Oct 25]. Available from: <http://wlab.fmed.ulaval.ca/projects/vcm/fr/>
48. Starmer C. Preference Reversals. In: The New Palgrave Dictionary of Economics. London: Palgrave Macmillan UK; 2017. p. 1–5.
49. Rottenstreich Y, Hsee CK. Money, kisses, and electric shocks: on the affective psychology of risk. *Psychol Sci*. 2001 May;12(3):185–90.
50. Hsee CK, Rottenstreich Y. Music, pandas, and muggers: on the affective psychology of value. *J Exp Psychol Gen*. 2004 Mar;133(1):23–30.
51. CRediT - CASRAI [Internet]. [cited 2017 Jun 23]. Available from: <http://docs.casrai.org/CRediT>

# APPENDICES

Appendix 1. Detailed Results of Individual Studies

Appendix 2. Sex-Stratified Summary Data

# Appendix 1: Detailed Results of Individual Studies

## Study 1

Table S1.1 Effects of Strategies 1a and 1b and Moderating Variables on Values Congruence (n=1346\*)

<b>Variable</b>	<b>OR (95% CI)</b>
Strategy 1a (compared to no intervention)	0.83 (0.62-1.11)
Strategies 1a + 1b (compared to no intervention)	1.09 (0.81-1.47)
Age	1.00 (0.99-1.01)
Male	0.95 (0.75-1.22)
Hispanic	0.83 (0.58-1.20)
Black	0.81 (0.49-1.31)
White	1.21 (0.80-1.81)
Self-Reported Health	1.11 (0.97-1.27)
Subjective Numeracy	1.02 (1.01-1.04)

\*For some studies, total n here is less than the total n reflected in Tables 1 and 2 in the main manuscript. These differences reflect small numbers of participants with missing data on the primary or secondary outcomes. Such participants were excluded from analyses.

## Study 2

Across both the control and strategy 2a conditions, 102 made a values-disgruent initial choice. Among these participants, providing feedback that their initial choice did not align with their previously stated values (strategy 2b) led to a values-congruent final choice for 33 participants (33%). More specifically, the values-congruent final choice in this subsample of people who initially made values-disgruent choices was estimated to be 31% (95% confidence interval 21%-44%) among participants who had not previously received a recommendation, and 36% (95% confidence interval 23%-51%) among participants who had also previously received a recommendation.

Table S1.2 Effects of Strategy 2a and Moderating Variables on Values Congruence of Initial Choice (n=432)

<b>Variable</b>	<b>OR (95% CI)</b>
Strategy 2a (compared to no intervention)	1.59 (1.01-2.54)
Age	1.00 (0.98-1.02)
Male	1.65 (1.03-2.65)
Black	1.43 (0.61-3.33)
Hispanic	1.06 (0.54-2.18)
White	1.80 (0.89-3.54)
Self-Reported Health	0.88 (0.68-1.14)
Subjective Numeracy	1.00 (0.97-1.03)

## Study 3

Table S1.3 Effects of Strategy 3 on Values Congruence and Decisional Conflict (n=838)

	<b>Values Congruence</b>	<b>Decisional Conflict less than or equal to 37.5/100</b>
<b>Variable</b>	<b>OR (95% CI)</b>	<b>OR (95% CI)</b>
Strategy 3 (compared to no intervention)	0.92 (0.66-1.28)	1.10 (0.82-1.46)
Age	1.01 (1.00-1.03)	1.00 (0.99-1.01)
Male	0.94 (0.67-1.34)	1.26 (0.93-1.71)
Black	2.69 (1.14-7.18)	1.11 (0.53-2.28)
Hispanic	1.87 (0.98-3.89)	1.41 (0.83-2.39)
White	1.45 (0.87-2.38)	1.42 (0.90-2.28)
Self-Reported Health	1.04 (0.87-1.26)	1.16 (0.99-1.37)
Subjective Numeracy	1.03 (1.01-1.05)	1.04 (1.02-1.06)
Preference for Deliberation	1.19 (0.88-1.59)	2.12 (1.61-2.82)
Preference for Intuition	0.98 (0.73-1.31)	1.29 (1.01-1.67)

## Study 4

Table S1.4 Effects of Strategies 4a and 4b on Values Congruence and Decisional Conflict (n=1176)

	<b>Values Congruence</b>	<b>Decisional Conflict less than or equal to 37.5/100</b>
<b>Variable</b>	<b>OR (95% CI)</b>	<b>OR (95% CI)</b>
Strategy 4a (compared to no intervention)	0.98 (0.70-1.37)	1.28 (0.96-1.71)
Strategy 4b (compared to no intervention)	1.04 (0.73-1.48)	1.54 (1.14-2.07)
Age	1.00 (0.99-1.02)	1.01 (1.00-1.02)
Male	1.11 (0.82-1.49)	1.46 (1.13-1.87)
Black	0.81 (0.46-1.46)	1.76 (1.03-3.00)
Hispanic	1.14 (0.66-2.08)	1.37 (0.85-2.21)
White	1.25 (0.81-1.89)	1.33 (0.92-1.95)
Self-Reported Health	1.03 (0.87-1.21)	0.88 (0.77-1.01)
Subjective Numeracy	1.02 (1.00-1.04)	1.03 (1.01-1.05)
Preference for Deliberation	1.23 (0.94-1.61)	1.84 (1.44-2.36)
Preference for Intuition	0.81 (0.63-1.03)	1.32 (1.08-1.63)

## Study 5

Table S1.5 Effects of Strategy 5 on Values Congruence and Decisional Conflict (n=840)

	<b>Values Congruence</b>	<b>Decisional Conflict less than or equal to 37.5/100</b>
<b>Variable</b>	<b>OR (95% CI)</b>	<b>OR (95% CI)</b>
Strategy 5 (compared to no intervention)	1.27 (0.90-1.80)	1.37 (1.03-1.82)
Age	1.00 (0.99-1.02)	1.02 (1.00-1.03)
Male	0.83 (0.57-1.20)	1.20 (0.88-1.62)
Black	2.00 (0.88-5.05)	1.39 (0.70-2.76)
Hispanic	0.89 (0.47-1.81)	1.21 (0.67-2.18)
White	1.65 (0.98-2.73)	1.41 (0.89-2.26)
Self-Reported Health	1.04 (0.86-1.26)	1.07 (0.91-1.25)
Subjective Numeracy	1.02 (1.00-1.05)	1.04 (1.02-1.06)
Preference for Deliberation	1.40 (1.03-1.90)	1.93 (1.47-2.56)
Preference for Intuition	0.79 (0.58-1.070)	1.26 (0.98-1.61)

## Study 6

Table S1.6 Effects of Strategy 6a on Values Congruence and Decisional Conflict (n=785)

Variable	Values Congruence	Decisional Conflict less than or equal to 37.5/100
	OR (95% CI)	OR (95% CI)
Strategy 6a (compared to no intervention)	0.92 (0.65-1.29)	1.70 (1.27-2.29)
Age	1.01 (0.99-1.03)	1.01 (0.99-1.02)
Male	1.07 (0.75-1.53)	1.36 (1.00-1.85)
Black	1.34 (0.63-2.98)	1.67 (0.82-3.41)
Hispanic	1.26 (0.62-2.81)	1.05 (0.55-2.00)
White	1.48 (0.88-2.45)	1.56 (0.98-2.53)
Self-Reported Health	1.02 (0.84-1.24)	1.09 (0.92-1.29)
Subjective Numeracy	1.03 (1.01-1.05)	1.03 (1.01-1.05)
Preference for Deliberation	1.26 (0.93-1.71)	2.21 (1.66-2.98)
Preference for Intuition	0.88 (0.65-1.20)	1.29 (0.99-1.68)

Table S1.7 Effects of Strategies 6b and 6c on Values Congruence and Decisional Conflict compared to Strategy 6a (n=1607)

Variable	Values Congruence	Decisional Conflict less than or equal to 37.5/100
	OR (95% CI)	OR (95% CI)
Strategy 6b only (compared to 6a)	1.48 (1.04-2.12)	0.80 (0.60-1.08)
Strategy 6c only (compared to 6a)	1.41 (0.99-2.00)	0.91 (0.68-1.22)
Strategies 6b + 6c (compared to 6a)	1.86 (1.29-2.70)	0.89 (0.66-1.19)
Age	1.00 (0.99-1.01)	1.01 (1.00-1.02)
Male	0.90 (0.69-1.18)	1.07 (0.87-1.32)
Black	0.63 (0.38-1.08)	0.95 (0.62-1.47)
Hispanic	0.75 (0.45-1.31)	1.06 (0.68-1.67)
White	0.85 (0.55-1.28)	1.23 (0.89-1.70)
Self-Reported Health	0.93 (0.80-1.08)	1.19(1.05-1.35)
Subjective Numeracy	1.02 (1.00-1.04)	1.03 (1.02-1.05)
Preference for Deliberation	1.14 (0.91-1.43)	1.73 (1.43-2.09)
Preference for Intuition	1.01 (0.81-1.26)	1.40 (1.17-1.67)

## Appendix 2: Descriptive Statistics by Participant Sex

Table S2.1 Study 1

	Study 1 (n = 1346)								
Characteristic	Control (n = 442)			Strategy 1a (n = 459)			Strategy 1a + 1b (n = 445)		
	ALL	Male (n = 232)	Female (n=210)	ALL	Male (n = 230)	Female (n = 229)	ALL	Male (n = 217)	Female (n = 228)
Congruence	313 (68)	169 (73)	181 (78)	319 (72)	159 (69)	173 (75)	329 (74)	159 (73)	165 (76)
Age in years: Median (IQR)	50 (38-60)	51 (38-59)	50 (38-60)	50 (38-59)	53 (39-59)	48 (37-58)	49 (37-58)	50 (38-58)	49 (37-58)
Black: N (%)	53 (12)	24 (10)	29 (14)	77 (17)	43 (19)	34 (15)	61 (14)	28 (13)	33 (14)
Hispanic: N (%)	52 (12)	36 (16)	16 (8)	56 (12)	23 (10)	33 (14)	59 (13)	26 (12)	33 (15)

White: N (%)	346 (78)	181 (78)	165 (79)	346 (75)	173 (75)	173 (76)	340 (76)	165 (76)	175 (77)
Self-Reported Health: Median (IQR)	2 (2-3)	2 (2-3)	2 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)
Subjective Numerac: Median (IQR)	35 (29-42)	38 (31-43)	34 (26-40)	36 (29-40)	37 (32-41)	33 (27-39)	36 (29-41)	38 (32-41)	34 (27-39)

Table S2.2 Study 2

<b>Study 2 (n = 456)</b>									
<b>Characteristic</b>	<b>Control (n = 217)</b>			<b>Strategy 2a (n = 239)</b>			<b>Strategy 2b (n = 102)</b>		
Sex	ALL	Male (n = 99)	Female (n = 110)	ALL	Male (n = 130)	Female (n = 102)	ALL	Male (n = 41)	Female (n = 57)
Congruence 1	158 (73)	79 (80)	74 (67)	196 (82)	109 (84)	81 (79)	33 (33)	14 (34)	18 (33)
Age in years: Median (IQR)	51 (40-60)	52 (42-59)	51 (39-61)	50 (40-58)	52 (44-59)	46 (38-56)	51 (38-60)	53 (46-60)	51 (37-59)
Black: N (%)	39 (18)	15 (15)	23 (21)	37 (15)	22 (17)	13 (13)	18 (18)	10 (24)	8 (14)
Hispanic: N (%)	32 (15)	15 (15)	15 (14)	35 (15)	18 (14)	15 (15)	17 (17)	2 (5)	13 (23)
White: N (%)	151 (70)	71 (72)	74 (67)	172 (72)	92 (71)	75 (74)	67 (66)	28 (68)	35 (61)

Self-Reported Health: Median (IQR)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-3)	3 (2-4)	3 (2-3)
Subjective Numeracy: Median (IQR)	34 (28-40)	37 (31-41)	32 (26-38)	34 (28-40)	36 (30-41)	33 (27-39)	33 (29-40)	36 (30-41)	31 (27-38)

Table S2.3 Study 3

Variable	Control (n=422)			Strategy 3 (n=418)		
	ALL	Male (n = 185)	Female (n = 237)	ALL	Male (n = 183)	Female (n = 235)
Congruence	330 (78)	146 (79)	184 (78)	321 (77)	138 (75)	183 (78)
Decisional conflict <=37.5	171 (41)	83 (45)	88 (37)	178 (43)	83 (45)	95 (40)
Age in years: Median (IQR)	27 (22-39)	26 (21-32)	28 (23-42)	27 (22-37)	26 (22-34)	28 (23-41)
Black: N (%)	23 (6)	5 (3)	18 (8)	26 (6)	10 (6)	16 (7)
Hispanic: N (%)	28 (7)	11 (6)	17 (7)	41 (10)	17 (9)	24 (10)
White: N (%)	355 (84)	160 (86)	195 (82)	354 (85)	158 (86)	196 (83)

Self-Reported Health: Median (IQR)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)
Subjective Numeracy: Median (IQR)	39 (33-42)	40 (36-43)	37 (31-42)	38 (32-43)	40 (35-44)	36 (30-42)
Preference for Deliberation: Median (Q1-Q3)	3.9 (3.7-4.2)	3.9 (3.6-4.2)	3.9 (3.7-4.3)	3.9 (3.4-4.3)	3.9 (3.4-4.3)	4.0 (3.4-4.3)
Preference for Intuition: Median (Q1-Q3)	3.3 (2.9-3.7)	3.2 (2.9 (3.7)	3.4 (3.0-3.8)	3.3 (2.9-3.7)	3.2 (2.9-3.6)	3.4 (3.0-3.8)

Table S2.4 Study 4

Variable	Strategy 4a (n=406)			Strategy 4b (n=350)		
	All	Male (n = 185)	Female (n = 221)	All	Male (n = 177)	Female (n=173)
Congruence	316 (78)	146 (79)	170 (77)	276 (79)	145 (82)	131 (76)
Decisional conflict <=37.5	192 (47)	99 (54)	93 (42)	182 (52)	97 (55)	85 (49)
Age in years: Median (IQR)	28 (22-35)	25 (21-32)	29 (23-42)	26 (22-35)	26 (21-34)	27 (22-36)
Black: N (%)	33 (8)	10 (5)	23 (10)	34 (10)	15 (9)	19 (11)
Hispanic: N (%)	30 (7)	18 (10)	12 (5)	24 (7)	9 (5)	15 (9)
White: N (%)	337 (83)	149 (81)	188 (85)	285 (81)	139 (79)	146 (84)

Self-Reported Health: Median (IQR)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)
Subjective Numeracy: Median (IQR)	38 (32-43)	40 (35-44)	36 (29-43)	38 (32-43)	40 (34-44)	36 (30-42)
Preference for Deliberation: Median (Q1-Q3)	3.9 (3.7-4.3)	3.9 (3.7-4.2)	4.0 (3.6-4.3)	4.0 (3.7-4.3)	4.0 (3.6-4.4)	4.0 (3.8-4.3)
Preference for Intuition: Median (Q1-Q3)	3.3 (2.9-3.8)	3.2 (2.9-3.8)	3.3 (3.0-3.8)	3.3 (3.0-3.8)	3.2 (2.9-3.7)	3.4 (3.0-3.9)

Table S2.5 Study 5

<b>Variable</b>	<b>Strategy 5 (n=419)</b>		
Sex	All	Male (n = 194)	Female (n = 225)
Congruence	344 (82)	155 (80)	189 (84)
Decisional conflict <=37.5	202 (48)	95 (49)	107 (48)
Age in years: Median (IQR)	28 (22-37)	26 (21-33)	31 (23-42)
Black: N (%)	28 (7)	15 (8)	13 (6)
Hispanic: N (%)	26 (6)	8 (4)	18 (8)
White: N (%)	364 (87)	167 (86)	197 (88)

Self-Reported Health: Median (IQR)	2 (2-3)	2 (2-3)	2 (2-3)
Subjective Numeracy: Median (IQR)	38 (32-43)	41 (36-45)	36 (29-42)
Preference for Deliberation: Median (Q1-Q3)	4.0 (3.6-4.3)	4.0 (3.6-4.3)	3.9 (3.6-4.3)
Preference for Intuition: Median (Q1-Q3)	3.3 (3.0-3.7)	3.3 (2.9-3.6)	3.3 (3.0-3.8)

Table S2.6 Study 6 Strategies 6a and 6b

Variable	Strategy 6a (n=363)			Strategy 6b (n=395)		
	All	Male (n = 178)	Female (n = 185)	All	Male (n = 186)	Female (n = 209)
Sex	All	Male (n = 178)	Female (n = 185)	All	Male (n = 186)	Female (n = 209)
Congruence	278 (77)	139 (78)	139 (75)	327 (83)	152 (82)	175 (84)
Decisional conflict <=37.5	193 (53)	99 (56)	94 (51)	189 (48)	91 (49)	98 (47)
Age in years: Median (IQR)	27 (22-39)	26 (22-33)	28 (23-40)	26 (22-36)	25 (21-35)	27 (23-36)
Black: N (%)	29 (8)	11 (6)	18 (10)	36 (9)	13 (7)	23 (11)
Hispanic: N (%)	18 (5)	13 (7)	5 (3)	23 (6)	13 (7)	10 (5)
White: N (%)	298 (82)	143 (80)	155 (84)	314 (79)	142 (76)	172 (82)

Self-Reported Health: Median (IQR)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)
Subjective Numeracy: Median (IQR)	38 (33-43)	39 (34-44)	37 (32-42)	38 (32-43)	40 (34-43)	37 (30-42)
Preference for Deliberation: Median (Q1-Q3)	3.9 (3.6-4.3)	3.9 (3.6-4.3)	4.0 (3.6-4.3)	3.9 (3.6-4.2)	3.9 (3.6-4.2)	3.9 (3.6-4.3)
Preference for Intuition: Median (Q1-Q3)	3.3 (3.0-3.8)	3.2 (3.0-3.7)	3.3 (3.0-3.9)	3.3 (3.0-3.7)	3.2 (2.9-3.6)	3.4 (3.1-3.8)

Table S2.6 Study 6 Strategies 6c and 6b+6c

Variable	Strategy 6c (n=440)			Strategies 6b + 6c (n=413)		
	All	Male (n = 194)	Female (n = 246)	All	Male (n = 193)	Female (n = 220)
Congruence	361 (82)	160 (82)	201 (82)	354 (86)	162 (84)	192 (87)
Decisional conflict <=37.5	222 (51)	99 (51)	123 (50)	212 (51)	94 (49)	118 (54)
Age in years: Median (IQR)	27 (22-37)	26 (21-33)	28 (23-38)	27 (22-39)	26 (22-34)	28 (23-42)
Black: N (%)	43 (10)	15 (8)	28 (11)	36 (9)	14 (7)	22 (10)
Hispanic: N (%)	26 (6)	10 (5)	16 (7)	324 (6)	14 (7)	10 (5)
White: N (%)	356 (81)	159 (82)	197 (80)	350 (85)	166 (86)	184 (84)

Self-Reported Health: Median (IQR)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-3)
Subjective Numeracy: Median (IQR)	38 (32-42)	40 (34-43)	37 (31-42)	38 (33-43)	40 (35-44)	38 (30-42)
Preference for Deliberation: Median (Q1-Q3)	3.9 (3.6-4.3)	3.9 (3.4-4.3)	4.0 (3.7-4.4)	3.9 (3.6-4.3)	4.0 (3.6-4.3)	3.9 (3.6-4.3)
Preference for Intuition: Median (Q1-Q3)	3.3 (3.9-3.7)	3.1 (2.8-3.4)	3.3 (3.0-3.8)	3.4 (3.0-3.8)	3.3 (2.9-3.7)	3.4 (3.1-3.8)