OPEN ACCESS

Choice architecture in physician–patient communication: a mixed-methods assessments of physicians' competency

Joanna Hart ,[1,2,3,4] Kuldeep Yadav ,[1] Stephanie Szymanski,[1] Amy Summer,[1] Aaron Tannenbaum,[1,2] Julian Zlatev ,[5] David Daniels,[6] Scott D Halpern[1,2,3,4]

► Additional material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjqs-2020-011801).

For numbered affiliations see end of article.

Correspondence to
Dr Joanna Hart, Palliative and Advanced Illness Research Center, Center for Health Incentives and Behavioral Economics, University of Pennsylvania, Philadelphia, PA 19104, USA;
joanna.hart@pennmedicine.upenn.edu

Received 16 June 2020
Revised 21 November 2020
Accepted 11 December 2020

To cite: Hart J, Yadav K, Szymanski S, *et al*. *BMJ Qual Saf* Epub ahead of print: [please include Day Month Year]. doi:10.1136/bmjqs-2020-011801

ABSTRACT

Background Clinicians' use of choice architecture, or how they present options, systematically influences the choices made by patients and their surrogate decision makers. However, clinicians may incompletely understand this influence.

Objective To assess physicians' abilities to predict how common choice frames influence people's choices.

Methods We conducted a prospective mixed-methods study using a scenario-based competency questionnaire and semistructured interviews. Participants were senior resident physicians from a large health system. Of 160 eligible participants, 93 (58.1%) completed the scenario-based questionnaire and 15 completed the semistructured interview. The primary outcome was choice architecture competency, defined as the number of correct answers on the eight-item scenario-based choice architecture competency questionnaire. We generated the scenarios based on existing decision science literature and validated them using an online sample of lay participants. We then assessed senior resident physicians' choice architecture competency using the questionnaire. We interviewed a subset of participating physicians to explore how they approached the scenario-based questions and their views on choice architecture in clinical medicine and medical education.

Results Physicians' mean correct score was 4.85 (95% CI 4.59 to 5.11) out of 8 scenario-based questions. Regression models identified no associations between choice architecture competency and measured physician characteristics. Physicians found choice architecture highly relevant to clinical practice. They viewed the intentional use of choice architecture as acceptable and ethical, but felt they lacked sufficient training in the principles to do so.

Conclusion Clinicians assume the role of choice architect whether they realise it or not. Our results suggest that the majority of physicians have inadequate choice architecture competency. The uninformed use of choice architecture by clinicians may influence patients and family members in ways clinicians may not anticipate nor intend.

INTRODUCTION

Shared decision making is a common and desirable component of clinical medicine that requires clinicians to guide patients and their surrogate decision makers through preference-sensitive healthcare decisions.[1] Although expertise in communication is a core competency for clinicians, they may lack sufficient understanding of human decision making to guide choices purposefully and ethically. For example, clinicians may not be aware of how decision makers respond to particular choice presentations in predictable, scientifically established ways. Indeed, recent work has shown that professional groups who are regularly in positions to influence the choices of others lack such competency.[2–4]

Choice architecture refers to the environment in which people make decisions.[5 6] The architect of a building creates a design that influences how people move throughout that physical space. There is no 'neutral' building design because the resulting environment, such as the placement of stairs relative to the elevators, invariably influences how people move about the building.[5] Similarly, there is no neutral choice architecture because every manner of presenting choices shapes how decision makers evaluate and select options.[7–9] The ways in which clinicians structure information about medical options influence how patients and their surrogates think about the available choices and make decisions, even when the clinician does not intend to influence the decision maker in any given

direction.[10] Therefore, clinicians must consider how their presentation of choices may persuade patients to select or avoid certain choices in their inevitable roles as choice architects.[11]

Physicians who are unable to understand choice architecture and its implications may present choices to patients and surrogates in a manner that influences their choices in ways the physicians did not recognise.[12] Physicians' duties to maximise the welfare of their patients means that they must consider the positive or negative consequences of their choice architecture, including subtle differences in how they present options or information. However, whether physicians are able to predict or even recognise these consequences is unknown. This study aims to assess the extent to which physicians are able to anticipate the influence of different choice presentations on decision makers, explore their perspectives on the applicability and ethical boundaries of choice architecture in healthcare, and examine the sources of their relevant knowledge of choice architecture.

METHODS

Study design

From September 2016 to March 2017, we used a mixed-methods approach to assess physicians' choice architecture competency (online supplemental appendix 1). First, we developed scenario-based questionnaire items to examine choice architecture competency using existing decision science literature. Second, we validated the questionnaire items through a randomised survey using an online research panel of laypersons. Third, we administered the final scenario-based questionnaire to senior resident physicians. These physicians all were in their final year of training in a clinical specialty that includes frequent communication with patients and surrogate decision makers. Fourth, we conducted semistructured interviews with a subset of participating physicians to explore their answers to the scenario-based questionnaire, the sources of their knowledge of choice architecture and their views on the ethical use of choice architecture in clinical medicine. Lastly, we conducted member checking among several interviewed physicians.

All subjects provided informed consent to participate.

Development and validation of scenarios to assess choice architecture competency

First, we developed the scenario-based items for the choice architecture competency questionnaire based on existing decision science literature.[6 7 13–17] We modified scenarios used in published experiments to make them applicable to the healthcare setting and evaluate physicians' understanding of choice architecture. Each preliminary item was structured similarly: respondents would predict the relative effect of two choice environments (A vs B) on a decision maker or individual patient (online supplemental appendix 2).

Second, we tested the validity of our proposed correct answers for these proposed competency questionnaire items using online participants. Essentially, this step allowed us to confirm that the choice environments included in our final set of scenario-based items affected lay individuals in the manner we expected based on the decision science literature. We provide an example of a competency questionnaire item and the validation step items in online supplemental appendix 2. We recruited 269 online Amazon Mechanical Turk (MTurk) users who were fluent in written English and >18 years old. MTurk is a crowdsourcing platform commonly used for research because researchers can rapidly recruit individuals to complete surveys and tasks posted on the MTurk website.[18] We provided them with nominal compensation in US dollars. Their mean age was 32.0 years (SD=2.4), and their median completion time was 21 min (IQR=12–37). Additional demographic information about the MTurk sample is detailed in online supplemental appendix 3. All MTurk participants viewed the three items assessing default effect, endowment effect and social norms. They were randomised to one of two choice environments (presentation 1 or presentation 2) and made a selection (online supplemental appendix 2) for the remaining seven items (online supplemental appendix 4). We compared their selections or responses for each item using the Student's t-test (online supplemental appendix 4). If there was a statistically significant difference in MTurk participants' selections in the direction supported by the published evidence, then we considered the proposed competency questionnaire item valid. We validated 7 of the 10 scenarios with the MTurk participants and included only these validated items in the physicians' scenario-based competency questionnaire. We added an eighth item involving the frequency of dosing and medication adherence. Because this item is focused on behaviour over time (ie, adherence given different prescribed medication regimens), this item was not amenable to survey validation. We included this item based on prior empirical work on medication adherence that validates a single correct answer (ie, that daily medication regimens are associated with greater adherence than intermittent regimens).[19] Of the final eight items, seven represent direct influences on decision makers' choice behaviour (ie, choice architecture). The remaining item, anchoring bias, does not represent a direct influence on decision makers' choice behaviour, but rather an influence on decision makers' risk estimation that may be used for their future medical choices.

Research participants

We administered the choice architecture competency questionnaire to senior resident physicians. We identified physicians in their final year of accredited residency training from three hospitals within a tertiary academic health system. We chose these physicians as

they were nearing clinical independence, functioned with a high degree of clinical independence given their seniority and were likely to engage in shared decision making. All eligible physicians were fluent in written English, ≥18 years old and enrolled in programmes recognised by the Accreditation Council for Graduate Medical Education. Physicians on leave during the study period were excluded. Specialties that did not require substantial face-to-face contact with patients were excluded. The included patient-facing specialties were anaesthesiology, dermatology, emergency medicine, family medicine and community health, internal medicine, neurology, obstetrics and gynaecology, physical medicine and rehabilitation, psychiatry, radiation oncology, general surgery, and surgical specialties including ophthalmology, orthopaedics, otolaryngology and urology. A database of all potentially eligible residents was compiled using the staff directories of the health system. All physicians in the database were invited via email to participate in the scenario-based questionnaire.

We recruited a subset of physicians who completed the competency questionnaire to participate in semi-structured interviews. We did not offer participation to all originally approached physicians nor to all physicians who completed the competency questionnaire. Physicians were selected for these interviews sequentially based on their scores on the questionnaire and their clinical specialty. We sought to represent physicians with a range of competencies in choice architecture and from diverse medical specialties. These interviews explored physicians' responses to the scenario-based questions, their views on how relevant, influential and ethical choice architecture is in medical practice, as well as the sources of their knowledge about choice architecture.

Choice architecture competency questionnaire for physicians

Using the web-based Qualtrics platform (Provo, Utah), we administered the eight-item validated, scenario-based questionnaire to physicians and assessed their competency in eight decision-making principles of choice architecture (table 1).[20] Consenting physicians received the eight scenario-based questions in random order (online supplemental appendices 5 and 6). For each question, physicians reviewed both choice presentations (1 and 2) and indicated how a particular presentation would influence the decision maker's selection of choice options (A or B) in comparison with the other presentation. In other words, physicians were asked to predict the relative effect of two choice presentations (1 or 2) on choice options (A or B). We included a neutral option (C) if physicians felt that the given choice presentations would not predictably influence the decision maker to select a particular choice option (A or B). We included two additional, unscored questions that had no clear direction of influence in fixed positions (ie, questions 1 and 6) to encourage the selection of the neutral option as an acceptable response (online supplemental appendix 5). These unscored items were not validated in the same way as our other items, but were based on existing decision science literature and presented conflicting influences. Therefore, they had no obvious correct answers based on the presented choice architecture. We also asked physicians to report their sociodemographic information, including their political party affiliation and political views. These questions are relevant because they are the only sociodemographic characteristics that have been consistently associated with views on the acceptability of nudging or the intentional use of choice architecture to influence behaviour.[21] Physicians were compensated US$25 for completing the questionnaire.

We used descriptive statistics to examine physicians' characteristics. We calculated the primary outcome of physicians' competency in choice architecture as the number of correct answers out of the eight scenario-based questions. We conducted linear regressions to examine the association between physicians' characteristics and choice architecture competency. All statistical analyses were performed in RStudio (V.1.1.456, RStudio, Boston, Massachusetts)[22] using the R

Table 1 Decision-making principles of choice architecture included in the scenario-based questionnaire

Principle	Explanation
Anchoring bias	People tend to rely heavily on the first piece of information, or 'anchor', when making decisions.
Compromise effect	A less 'attractive' or less preferable choice increases the attractiveness of another, alternative choice.
Default effect	The 'default' is the result when no explicit decision for an alternative option is made.
Framing effect	People tend to prefer certainty in a gain frame (ie, saving lives) and uncertainty in a loss frame (ie, losing lives).
Habit formation	People tend to adhere to their routine activities and resolutions if they engage them on a regular basis.
Multiple alternatives bias	A multiplicity of options may lead to significant conflict and uncertainty, resulting in lack of a decision or a response of 'I don't know' or 'let me get another opinion'.
Relative risk bias	People tend to interpret relative risk differently when presented as percentages and when presented as ratios. People often interpret ratios more strongly than percentages.
Social norms	Rules or behaviours that are considered socially acceptable by a cohort or group. It is understood by all members of the group that they should abide by these norms.

language for statistical computing (V.4.0.1, R Foundation, Vienna, Austria)[23] and the tidyverse package (V.1.3.0).

Semistructured interviews

The interview focused on obtaining a deeper understanding of physicians' rationales for their answers on the questionnaire and views on the training in and use of choice architecture in medicine. Two investigators (KY and SS) conducted and recorded the interviews individually with the participating physicians. We reviewed the physicians' own answers to five of the scenario-based questions and asked them to explain the rationale for each answer. We limited the number of reviews to prevent fatigue and varied the items we explored with each physician so that multiple physicians reviewed all the items. We also informed physicians of the correct answer, provided the relevant supporting evidence from the literature, and gathered their responses to and acceptance of this new information. We then elicited physicians' views on the applicability and ethicality of using specific choice architecture principles that may influence healthcare decision makers. Finally, we prompted physicians to describe any prior or ongoing training in choice architecture or related communication principles. Physicians were compensated US$50 for participating in the interview.

Audio-recorded interviews were transcribed verbatim by a professional transcription service. Four investigators (JLH, KY, AS, and SS) generated a preliminary codebook based on the interview content. We independently coded the interview transcripts in duplicate, reviewed the coding for discrepancies and reached an agreement on the application of codes in regular coding meetings. Throughout the qualitative analysis, we updated and refined the codebook and interview guide as necessary. Three investigators (JLH, KY, and SS) then independently reviewed the content of the codes in order to identify emergent themes and subsequently met as an analytic team to reach a consensus on the results. Interviews continued until we achieved thematic saturation after 15 interviews, at which point no new themes emerged during further content analysis.

Finally, we performed synthesised member checking among physicians to validate our qualitative results and limit the potential for researcher bias. Member checking, also known as respondent validation, enables the studied population to review, contribute to, and further corroborate or refine the qualitative research findings.[24] We provided the interviewed physicians an opportunity to review the major themes identified from the interview transcripts using an emailed Qualtrics survey. We asked them to indicate whether the findings resonated with their own experience and explain any perceived inaccuracies.

Table 2 Characteristics of physicians (N=93)

Characteristics	
Age (in years)	
Mean (SD)	30.2 (2.4)
Median (IQR)	30.0 (29.0–31.0)
Gender, n (%)	
Male	57 (61.3)
Female	36 (38.7)
Race, n (%)	
White and/or Caucasian American*	56 (60.2)
Black and/or African American	3 (3.2)
Asian and/or Asian American*	27 (29.0)
Other	8 (7.6)
Ethnicity, n (%)	
Hispanic	2 (2.0)
Non-Hispanic	91 (97.8)
Medical specialty, n (%)	
Anaesthesiology	15 (16.1)
Internal medicine	34 (36.6)
Emergency medicine	10 (10.8)
Surgery†	11 (12.0)
Other‡	23 (24.9)
Political views, n (%)	
Conservative	6 (6.5)
Moderate	32 (34.4)
Liberal	52 (55.9)
Not specified	3 (3.2)
Political party, n (%)	
Democrat	61 (65.6)
Republican	12 (12.9)
Libertarian	3 (3.2)
Socialist	1 (1.1)
Not specified	16 (17.2)

*One participant identified as both white and/or Caucasian American and Asian and/or Asian American.
†Surgery includes general surgery, ophthalmology, orthopaedics, otolaryngology and urology.
‡Other includes dermatology, family medicine and community health, neurology, obstetrics and gynaecology, physical medicine and rehabilitation, psychiatry, and radiation oncology.

RESULTS

Assessment results

Of 160 eligible resident physicians, 93 (response rate (RR)=58.1%) completed the questionnaire. The mean age of physicians was 30.2 years (SD=2.4), and a majority identified themselves as male (n=57, 61.3%), Caucasian (n=56, 60.2%) and Democrat (n=61, 65.6%). The most represented medical specialties included internal medicine (36.6%), anaesthesia (16.1%), surgery and surgical subspecialties (11.8%), and emergency medicine (10.8%). These demographics are detailed in table 2 and representative of resident physicians at this tertiary academic health system.

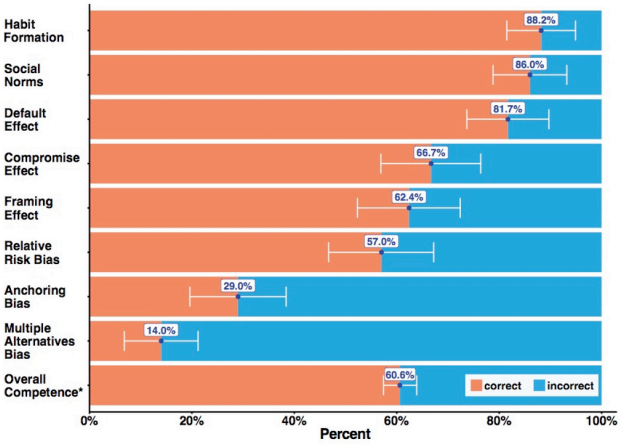


Figure 1 Proportion of physicians correctly predicting the influence of choice frames. *Total correct items out of 8.

Physicians correctly answered 4.85 correct out of 8 choice architecture competency items (SD=1.26; 95% CI 4.59 to 5.11) or 60.62% (SD=15.74; 95% CI 57.38 to 63.86; figure 1). Physicians demonstrated the highest competency in scenarios assessing habit formation, social norms and default effect. They demonstrated the lowest competency on scenarios assessing relative risk bias, anchoring effect and multiple alternatives bias. Linear regression identified no associations between physicians' characteristics and choice architecture competency (all p>0.05; online supplemental appendix 7).

Interview results

Of 28 invited resident physicians, 15 (RR=53.57%) completed the semistructured interview. This subset represented both high competency (score ≥6, n=8) and low competency (score <6, n=7) scorers. The median duration of the interview was 39 min (IQR=33–42 min, range=20–51 min). We invited 14 of these 15 interviewees to validate the results by member checking, as we could not locate a valid email address for the remaining interviewee. Of 14 invited physicians, 6 (RR=42.85%) responded, and all confirmed the validity of the themes that emerged from the interviews. The respondents identified no significant inaccuracies after reviewing the qualitative conclusions. Key themes are summarised in table 3.

Table 3 Themes from semistructured interviews of physicians

Themes	Representative quotations
Recognising choice architecture	
Choice architecture's relevance in the healthcare setting	"I think it applies a huge amount. I mean, every day…when we interact with patients, you have to give them their choices and their options."
Drawing on clinical experience to rationalise survey answers	"We do scopes through the nose. Sometimes we'll numb the nose and sometimes we won't. The last thing I say is 'we're not going to numb your nose, but it's fine. Everyone puts up with it.' [The patients] are like 'oh, okay' and they kind of go with it. So I think I do it almost on a daily basis."
The effects of some heuristics feel intuitive, while others are surprising	"I think multiple alternate bias sounds, is familiar to me. The other [choice architecture principles] are just more intuitive, like I mean social norms is very intuitive." "Well, since I answered the other way, I think it's not related or…that it shouldn't influence. Maybe it's my way of thinking about it, but it is very interesting, that concept of anchoring, in which people can make a decision based on a priming or a number given before."
Training in choice architecture	
Learning through the apprenticeship model	"I would say that most of [what I've learned] has been, the vast majority – 95% plus has been observing just the random current position you happen to be dealing with, how they happen to do it, seeing a bunch of people present options and trying to decide on your own what makes sense for you."
Learning on the fly	"We don't talk about these things usually. People just figure, at least in anesthesia, we just figure out how we present the options to patients. You may have watched someone else do it who's more senior to you, and then kind of picked up pieces from that like now I know how not to do it, or how to do it."
Training in choice architecture outside of medicine	"So, I was a software engineer prior to this. So, a lot of our programming classes talked about decision making and where patients click and why they click. So, we definitely talked about [choice architecture] there."
Ethics in using choice architecture	
Upholding patient autonomy	"I think that [the use of choice architecture] can lead us to a slippery slope and I think that if you're doing it simply to manipulate the patient into choosing what you feel might be the best option, it might be a little nefarious because ultimately autonomy is one of the pillars of the patient physician relationship and you must maintain that."
Acceptability of nudging in the patient's best interest	"…[choice architecture] is probably an unethical thing if you're doing it to deceive a patient or to force them to choose something. However, if they're making a bad decision for some other reason in your perception and you were trying to get them to do what's right for them or what may be in their best interest then it mitigates that or may make it the right thing to do."
Clear, honest communication regarding options as key to ethical discussions	"…as long as you don't have a conflict of interest, which I think is really important to set up in the beginning, then I do think that [nudging] is slightly ok. However, I think our role as physicians is not to ultimately make decisions for everyone, but to provide them with the information to make an informed decision themselves."
Importance of training in ethical considerations	"I mean, I think the only way to avoid [the unethical use of choice presentations] is to know about these biases, and to present to your patient as neutral and vanilla as a way you can…."

Choice architecture is highly relevant to healthcare

Physicians uniformly found the principles of choice architecture highly applicable to healthcare settings and the physician's role in shared decision making. Physicians recognised the importance of their communication in shaping decision makers' choices and health behaviours. For example, reflecting on the use of social norming, one physician noted:

> [I use social norming] all the time… People ask me, 'Are there people that don't get an epidural for this procedure?' And I would say, 'Very few wouldn't.' Because that's the truth… If I say that probably they're more likely, they'll be like, 'Well, then, I better get one even though I don't want you sticking a needle in my back…'

However, many physicians also felt that they did not always understand the likely influence of the choice presentation they used. One such physician remarked:

> I'm in a field where we talk a lot about risk vs benefits. I don't think I've ever had anyone formally discuss with me the importance of thinking about absolute vs relative risk and how that may bias a patient–or anchoring–which are all super relevant.

Physicians predict influences based on personal experiences

Physicians based their responses to scenario-based questions on prior professional experiences or their own anticipated responses. A minority of their responses were based on specific training or education. Reflecting on the influence of relative risk bias, one resident developed the following prediction:

> … if you say 20% experience a complication vs 10%, perfect, I'm, like, okay. But if you say it's twice as likely to cause a complication, then that sounds a lot more concerning *to me as a patient*…

In this way, physicians may have been more successful at predicting the impact of certain decision-making principles of choice architecture, such as social norms and default effect, because the influence of these principles seemed to be 'common sense' or more 'intuitive'. When their predictions based on personal reactions were incorrect, they found the choice architecture to be surprising, counterintuitive or 'shocking'. Physicians struggled to understand the influence of certain choice architecture on patients and caregivers due to differences in perspective and education. For example, some physicians were unable to predict the patient's response to a choice presentation because of prior professional training. Reflecting on the relative risk bias, one physician commented:

> [Physicians] are well versed in [statistics] and we can go back and forth between the percentages and the ratios. If you know both you probably may not be thinking about how you're presenting it to the patient. They don't know both. You do. So, for you to say twice as much or 20% vs 10%, it doesn't mean anything [to the physicians]. But it does to the patient.

Similarly, physicians scored poorly in predictions of anchoring bias. The rationale for their incorrect answers revealed that physicians were less susceptible to the specific anchoring scenario due to their medical knowledge and therefore were less likely to recognise its influence on patients:

> When providing or estimating the risk of a genetic disease, if the [patient's] oldest living relative is 90, compared to 50, there's a huge difference and it may be totally unrelated to the genetic disease. So I don't think that a number in and of itself, a random number, should have anything to do with what one assumes is a risk factor when estimating the likelihood of acquiring a genetic disease.

The apprenticeship model may lead to errors in understanding

Some physicians described limited training in choice architecture during medical school, while almost all physicians described learning about communication with patients and caregivers during their residency training. These communication skills, including the use of choice architecture, were developed by observing more senior or attending physicians through an *apprenticeship model*. One physician noted: "I have learned these [decision-making principles], but not in such an explicit way. It's more just through experiencing how my attending[s] talk." Another, at the end of 4 years of residency training, reflected that his or her communication of choice was shaped by the behaviours of attending physicians she witnessed early in her residency experience:

> In our first month of [residency]…[we] have 2 attendings for 2 weeks each. You watch them consent patients in the morning and then throughout the day. So, a lot of the ways I present things are based on those [attending physicians].

Since this method of experiential learning is neither explicit nor exhaustive, many physicians felt as though they had to 'learn on the fly' or by 'trial and error'. One physician illustrated:

> I have learned almost none of these in actual, like formal settings… all of these [decision-making principles] I have learned on the fly. [As an example,] the compromise effect, we kind of talked about… giving a couple more options… helps [the patients and their surrogates] understand what is the truly desirable choice [to them].

The minority of physicians who reported receiving didactic training on choice architecture did so largely outside of their medical education. Examples included undergraduate or graduate coursework in economics, psychology, computer science and statistics, as well as independent research into the subject due to personal interest.

Ethical boundaries exist when using choice presentations

The majority of physicians felt that choice architecture was acceptable when it promoted the patient's best interest, as determined by the physician:

> Depending on how you're presenting [choice options], you're going to influence patients' decisions. But that's kind of your job in the role of an expert consultant, is to influence or recommend. I think most people when they are influencing peoples' decisions are doing it from the place of trying to do what they think is best for the patient. I think that is always ethical…

A few physicians felt that the use of choice architecture could be ethically problematic as its use may infringe on the decision maker's autonomy and introduce elements of deception or manipulation. One physician remarked: "From an ethical standpoint, you should do a limited amount of influence other than presenting information and allowing patients to make an informed decision." Others recognised that the degree to which the choice architecture influenced the decision maker may inform its ethicality. For example: "I don't think you should use [decision-making principles] to push someone to one [option] wholeheartedly…because I think that takes away the option or decision that the patient gets to have."

In this way, physicians felt that the use of choice architecture must balance the promotion of patient autonomy and the need to guide decision makers towards a choice aligned with a patient's best interests. Ultimately, most physicians identified training in the use of choice architecture as crucial to promoting its ethical use. One physician concluded: "I think it's good to know what the literature actually shows because… even if you think you're presenting it in an unbiased way…you might be biasing them towards one option or another."

DISCUSSION

Clinicians frequently serve as choice architects, as the use of choice architecture is often unavoidable when presenting choices to decision makers.[25] Our interviewed physicians generally agreed that the decision-making principles of choice architecture are highly applicable to the healthcare setting. The perceived relevancy of choice architecture to physicians' professional role as clinical advisors may indeed facilitate efforts to improve their use of choice architecture. Furthermore, physicians felt that they could not use choice architecture ethically without sufficient knowledge of and competency in applying its principles. Our findings reveal that while physicians are able to predict the influence of certain decision-making principles, many physicians lack the ability to predict the influence of most choice architecture on healthcare decision makers.

Our current research and healthcare environment appropriately emphasises the importance of shared decision making in order to promote goal-concordant care.[26–29] Yet physicians are not sufficiently competent in choice architecture to fulfil their role as expert guides for these decisions. Participating physicians reported little to no explicit discussion of choice architecture in their clinical training. The use of an apprenticeship model to teach communication skills and principles inherently limits the improvement of these skills if the individuals who model the behaviours also lack adequate knowledge and competency in choice architecture. Our study did not test the competency of more senior clinicians, who would have had more experience directly observing the responses of patients and surrogates. However, the predictable influences of choice architecture have only been recently described.[5] Moreover, healthcare leaders and educators have only recently recognised the relevance of choice architecture to healthcare and integrated these concepts into system improvements and medical training.[30 31]

Our findings also suggest that some physicians believe the ability to communicate choice options to decision makers is a 'soft skill'. That is, this skill is one that does not require explicit, didactic instruction but is instead intuitive or developed through experiential learning and shared socialisation. Our results highlight the shortcomings of this approach. Physicians' current training and clinical education may, in fact, make it *more* difficult for them to predict how different choice architecture impacts decisions made by laypeople. An individual's susceptibility to certain heuristics and biases is highly dependent on his or her personal experiences and expertise.[32] Physicians have more comprehensive knowledge about the medical choices being considered, but they may not have corresponding knowledge of how to communicate those choice options to laypeople. Consequently, they will be less likely to recognise the effect of choice architecture on patients without such training.[33]

Some physicians' lack of sufficient competency in choice architecture may lead to ethical challenges in shared decision making. Clinicians who do not understand choice architecture cannot predict the direction or degree of its impact on an individual decision maker. Nevertheless, clinicians are responsible for the influence they have on decision makers in their role as choice architect. This influence may be unintended, but decision makers are still influenced towards or away from particular choices as a result. Only by understanding how decision-making principles influence decision makers can clinicians decide whether that influence, or the direction of that influence, is justifiable.[34] Therefore, future research is needed to identify the types of choice architecture that clinicians use most frequently in clinical practice, explore patients' and surrogates' views on the appropriate boundaries of clinicians'

use of choice architecture in shared decision making, and develop effective educational interventions to improve clinicians' competency in choice architecture. Further, this lays the foundation for future work exploring whether clinicians' choice architecture competencies and similar communication skills underlie the well-described variation in the care patients receive, especially when patients and surrogates face preference-sensitive decisions.[35 36]

Limitations

First, this study used hypothetical scenarios in the questionnaire. Although we did validate scenarios among laypeople on MTurk, responses to hypothetical scenarios may differ from the medical decisions that decision makers would actually make in the described scenarios. Physicians' abilities to predict decision makers' behaviours may also be different when completing a questionnaire as compared with the clinical setting. However, our goal was to assess knowledge, for which this format remains appropriate. Self-report statements may not reflect actual behaviours, which may have affected the validity of physicians' responses during the interviews. Second, we used a single scenario to assess competency in each choice architecture principle. Other scenarios assessing the same choice architecture principle may have yielded different responses by physicians, although the inclusion of multiple scenarios for each principle would have made the questionnaire more burdensome to participants. Third, there are numerous cognitive heuristics and biases not included in the questionnaire.[12] We selected decision-making principles that we hypothesised would influence preference-sensitive medical decisions, for which there was published literature supporting their direction of influence and for which the direction of influence was empirically validated by our MTurk sample. Fourth, participants may have experienced fatigue while completing either the questionnaire or the interview. However, we minimised the duration of both to reduce participant burden and compensated all participants for their time. Fifth, our sample size was sufficient for describing competency but did not allow us to explore variation in the data based on key physician-level characteristics, which will be an important future step in intervention development and implementation. Sixth, our study's recruitment of resident physicians from a single, large academic healthcare may limit the generalisability of our findings to physician populations at other institutions, those with greater clinical experience and non-physician clinicians. However, this limitation is somewhat mitigated as the included residents have been educated in varied training environments within a single institution because the residency programmes at the three hospitals have little to no shared educational programming. Clinicians who trained longer ago are also likely to have less exposure to choice architecture as a concept. Finally, the low response rate may reflect selection bias, as those with less interest in the topic may have elected not to participate in both the questionnaire and the subsequent interviews. However, this would lead to overestimates of both physicians' choice architecture competency and their recognition of the relevance of these principles to clinical practice. Therefore, this bias would emphasise the significance of our finding that clinicians may benefit from enhanced awareness of and training in the use of choice architecture.

CONCLUSIONS

Clinicians assume the role of the choice architect when presenting options to patients and other healthcare decision makers, whether or not they realise it. Clinicians must present choices and information as they engage in shared decision making, a process that is intended to promote care that is aligned with patients' values and preferences. However, our results suggest that many clinicians may have inadequate competency in choice architecture. Consequently, the uninformed use of choice architecture by clinicians may very well influence patients and family members in ways that the clinicians did not anticipate or intend. In light of our findings, future research should examine the impact of clinicians' choice architecture on patients' decisions and outcomes, as well as the development and testing of interventions to improve choice architecture competency among clinicians.

Author affiliations
[1]Palliative and Advanced Illness Research Center, University of Pennsylvania, Philadelphia, Pennsylvania, USA
[2]Division of Pulmonary, Allergy, and Critical Care, Department of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, USA
[3]Center for Health Incentives and Behavioral Economics, University of Pennsylvania, Philadelphia, Pennsylvania, USA
[4]Department of Medical Ethics and Health Policy, University of Pennsylvania, Philadelphia, Pennsylvania, USA
[5]Negotiation, Organizations & Markets Unit, Harvard Business School, Boston, Massachusetts, USA
[6]Department of Management, Business School, Hong Kong University, Hong Kong, Hong Kong

Twitter Joanna Hart @JHartMD and Kuldeep Yadav @KuldeepNYadav

Contributors All authors made substantial contributions to the conception or design of the work, or the acquisition, analysis or interpretation of data. All authors were involved in drafting the work or revising and reviewing it critically for important intellectual content. All authors gave final approval of the version published. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding This study was funded by the National Heart, Lung, and Blood Institute (K23HL132065) and Leonard Davis Institute - Center for Health Incentives and Behavioral

Economics Penn Roybal Center, National Institute on Aging (P30AG034546).

Disclaimer The funding sources played no role in designing the study, interpreting the data, or writing and publishing the manuscript.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The Institutional Review Board of the University of Pennsylvania approved this study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Protocols and analytic plans are available upon request. The full instruments were included in the supplemental materials. Data may be shared upon reasonable request in alignment with institutional policies.

ORCID iDs
Joanna Hart http://orcid.org/0000-0001-5617-741X
Kuldeep Yadav http://orcid.org/0000-0002-7661-6229
Julian Zlatev http://orcid.org/0000-0002-9427-9887

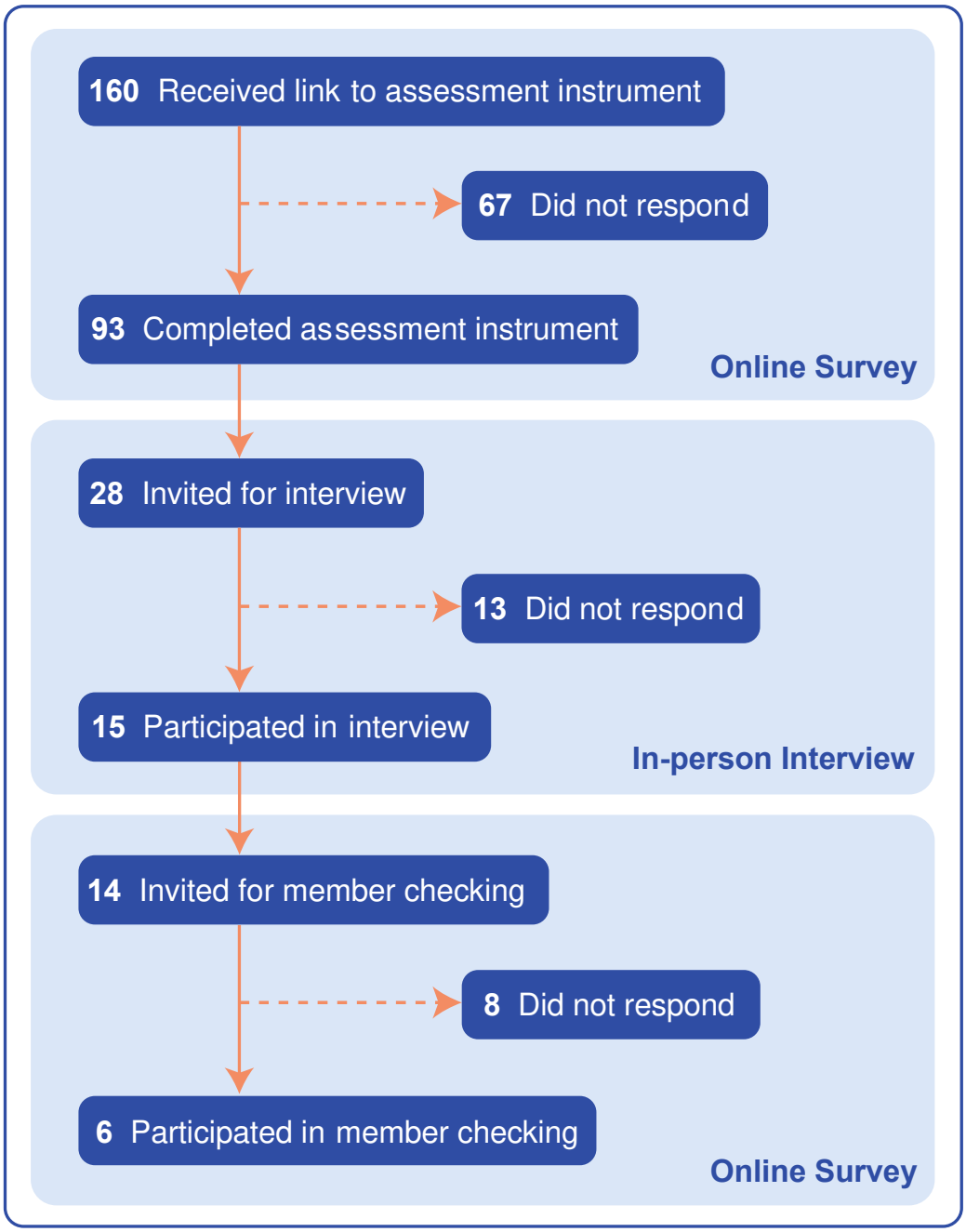
REFERENCES

1 Charles C, Gafni A, Whelan T. Decision-making in the physician-patient encounter: revisiting the shared treatment decision-making model. *Soc Sci Med* 1999;49:651–61.
2 Zlatev JJ, Daniels DP, Kim H, *et al*. Default neglect in attempts at social influence. *Proc Natl Acad Sci U S A* 2017;114:13643–8.
3 Daniels DP, Zlatev JJ. Choice architects reveal a bias toward positivity and certainty. *Academy of Management Proceedings* 2018;2018:18266.
4 Daniels DP, Neale MA. Prosocial distortions in influence strategies. *Acad Manage Proceed* 2019;2019:19018.
5 Thaler RH, Sunstein CR. *Nudge: improving decisions about health, wealth, and happiness*. New Haven, CT: Yale University Press, 2008.
6 Blumenthal-Barby JS, Krieger H. Cognitive biases and heuristics in medical decision making: a critical review using a systematic search strategy. *Med Decis Making* 2015;35:539–57.
7 Johnson EJ, Shu SB, Dellaert BGC, *et al*. Beyond nudges: tools of a choice architecture. *Mark Lett* 2012;23:487–504.
8 Simon HA. A behavioral model of rational choice. *Q J Econ* 1955;69:99–118.
9 Tversky A, Kahneman D. The framing of decisions and the psychology of choice. *Science* 1981;211:453–8.
10 Blumenthal-Barby JS, Burroughs H. Seeking better health care outcomes: the ethics of using the "nudge". *Am J Bioeth* 2012;12:1–10.
11 Hart J, Halpern SD. Default options in the ICU: widely used but insufficiently understood. *Curr Opin Crit Care* 2014;20:662–7.
12 Croskerry P. Achieving quality in clinical decision making: cognitive strategies and detection of bias. *Acad Emerg Med* 2002;9:1184–204.
13 Fudenberg D, Levine DK, Maniadis Z. On the robustness of anchoring effects in WTP and WTA experiments. *Am Econ J Microecon* 2012;4:131–45.
14 Simonson I. Choice based on reasons: the case of attraction and compromise effects. *Journal of Consumer Research* 1989;16:158–74.
15 Halpern SD, Loewenstein G, Volpp KG, *et al*. Default options in advance directives influence how patients set goals for end-of-life care. *Health Aff* 2013;32:408–17.
16 Levin IP, Schneider SL, Gaeth GJ. All frames are not created equal: a typology and critical analysis of framing effects. *Organ Behav Hum Decis Process* 1998;76:149–88.
17 Blumenthal-Barby JS, Lee D, Volk RJ. Toward ethically responsible choice architecture in prostate cancer treatment decision-making. *CA Cancer J Clin* 2015;65:257–60.
18 Chandler J, Rosenzweig C, Moss AJ, *et al*. Online panels in social science research: expanding sampling methods beyond mechanical Turk. *Behav Res Methods* 2019;51:2022–38.
19 Costa E, Giardini A, Savin M, *et al*. Interventional tools to improve medication adherence: review of literature. *Patient Prefer Adherence* 2015;9:1303–14.
20 Qualtrics. Provo, UT: Qualtrics, Inc, 2018. Available: https://www.qualtrics.com
21 Tannenbaum D, Fox CR, Rogers T. On the misplaced politics of behavioural policy interventions. *Nat Hum Behav* 2017;1:0130.
22 RStudio Team. *RStudio: integrated development environment for R*. Boston, MA: RStudio, Inc, 2016. http://www.rstudio.com/
23 R Core Team. *R: a language and environment for statistical computing Vienna*. Austria: R Foundation for Statistical Computing, 2017. https://www.R-project.org/
24 Birt L, Scott S, Cavers D, *et al*. Member checking: a tool to enhance Trustworthiness or merely a NOD to validation? *Qual Health Res* 2016;26:1802–11.
25 Gorin M, Joffe S, Dickert N, *et al*. Justifying clinical Nudges. *Hastings Cent Rep* 2017;47:32–8.
26 Austin CA, Mohottige D, Sudore RL, *et al*. Tools to promote shared decision making in serious illness: a systematic review. *JAMA Intern Med* 2015;175:1213–21.
27 Sinuff T, Dodek P, You JJ, *et al*. Improving end-of-life communication and decision making: the development of a conceptual framework and quality indicators. *J Pain Symptom Manage* 2015;49:1070–80.
28 Tulsky JA, Beach MC, Butow PN, *et al*. A research agenda for communication between health care professionals and patients living with serious illness. *JAMA Intern Med* 2017;177:1361–6.
29 White DB, Malvar G, Karr J, *et al*. Expanding the paradigm of the physician's role in surrogate decision-making: an empirically derived framework. *Crit Care Med* 2010;38:743–50.

30 Reilly JB, Ogdie AR, Von Feldt JM, *et al*. Teaching about how doctors think: a longitudinal curriculum in cognitive bias and diagnostic error for residents. *BMJ Qual Saf* 2013;22:1044–50.
31 Patel MS, Volpp KG, Asch DA. Nudge units to improve the delivery of health care. *N Engl J Med* 2018;378:214–6.
32 Aczel B, Bago B, Szollosi A, *et al*. Measuring individual differences in decision biases: methodological considerations. *Front Psychol* 2015;6:6.
33 Camerer C, Loewenstein G, Weber M. The curse of knowledge in economic settings: an experimental analysis. *J Polit Econ* 1989;97:1232–54.
34 Sunstein C. The ethics of nudging. *Yale J on Reg* 2015;32.
35 Garland A, Shaman Z, Baron J, *et al*. Physician-attributable differences in intensive care unit costs: a single-center study. *Am J Respir Crit Care Med* 2006;174:1206–10.
36 Obermeyer Z, Powers BW, Makar M, *et al*. Physician characteristics strongly predict patient enrollment in hospice. *Health Aff* 2015;34:993–1000.

ONLINE APPENDICES

Appendix 1. Flow diagram depicting the participation of resident physicians



Appendix 2. Scenario development

Decision-making principle: **Relative Risk Bias**

Scenario presented to online MTurk participants (randomly assigned to presentation 1 or 2)

Presentation 1:

You have a newly diagnosed lung cancer. As your physician, I recommend that you select either Procedure A or Procedure B. Both procedures are equally effective but have different risks. Procedure A usually works and 20% of patients experience a complication. Procedure B may work and 10% of patients experience a complication.

Which option will you choose?

A. Procedure A

B. Procedure B

*represents choice selected by the majority of MTurk users

-OR-

Presentation 2:

You have a newly diagnosed lung cancer. As your physician, I recommend that you select either Procedure A or Procedure B. Both procedures are equally effective but have different risks. Procedure A usually works to solve the problem while Procedure B may work. Procedure A is twice as likely to cause a complication as Procedure B.

Which option will you choose?

A. Procedure A

B. Procedure B*

*represents choice selected by the majority of MTurk users

Scenario presented to all resident physicians

Scenario: You have a newly diagnosed lung cancer. As your physician, I recommend that you select either Procedure A or Procedure B. Both procedures are equally effective but have different risks. Both procedures are equally effective but have different risks.

Presentation 1:

Procedure A usually works and 20% of patients experience a complication. Procedure B may work and 10% of patients experience a complication.

Presentation 2:

Procedure A usually works to solve the problem while Procedure B may work. Procedure A is twice as likely to cause a complication as Procedure B.

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Procedure A

B. Procedure B*

C. Does not influence the likelihood that patient will choose either option.

*represents correct answer based on prior literature and validation by MTurk users

Appendix 3. Characteristics of Amazon Mechanical Turk (MTurk) participants

Characteristic	
Sample Size	269
Age, mean (SD)	32.0 (10.3)
Gender, n (%)	
Male	101 (37.5%)
Female	168 (62.5%)
Race, n (%)	
White and/or Caucasian American	209 (77.7%)
Black and/or African American	17 (6.3%)
Asian and/or Asian American	11 (4.1%)
Other	32 (11.9%)
Ethnicity, n (%)	
Hispanic	25 (9.3%)
Non-Hispanic	244 (90.7%)
Education, n (%)	
None	1 (0.4%)
High school graduate or GED	99 (36.8%)
Some college, no degree	6 (2.2%)
Associate's degree	12 (4.5%)
Bachelor's degree	117 (43.5%)
Master's degree	26 (9.7%)
Doctorate or professional degree	8 (3.0%)
Employment status, n (%)	
Employed	179 (66.5%)
Self-employed	15 (5.6%)
Unemployed	20 (7.4%)
Stay-at-home parent	20 (7.4%)
Retired	6 (2.2%)
Student	29 (10.8%)

Appendix 4. Validation results from Amazon Mechanical Turk (MTurk)

3A. Scenarios presented to all MTurk Participants (n=269)

Principle				p-value
		Option A	Option B	
Default Effect	**n (%)**	249 (93%)	20 (7%)	**<0.001***
Endowment Effect		112 (42%)	157 (58%)	0.01**
Social Norms		195 (73%)	74 (27%)	**<0.01***

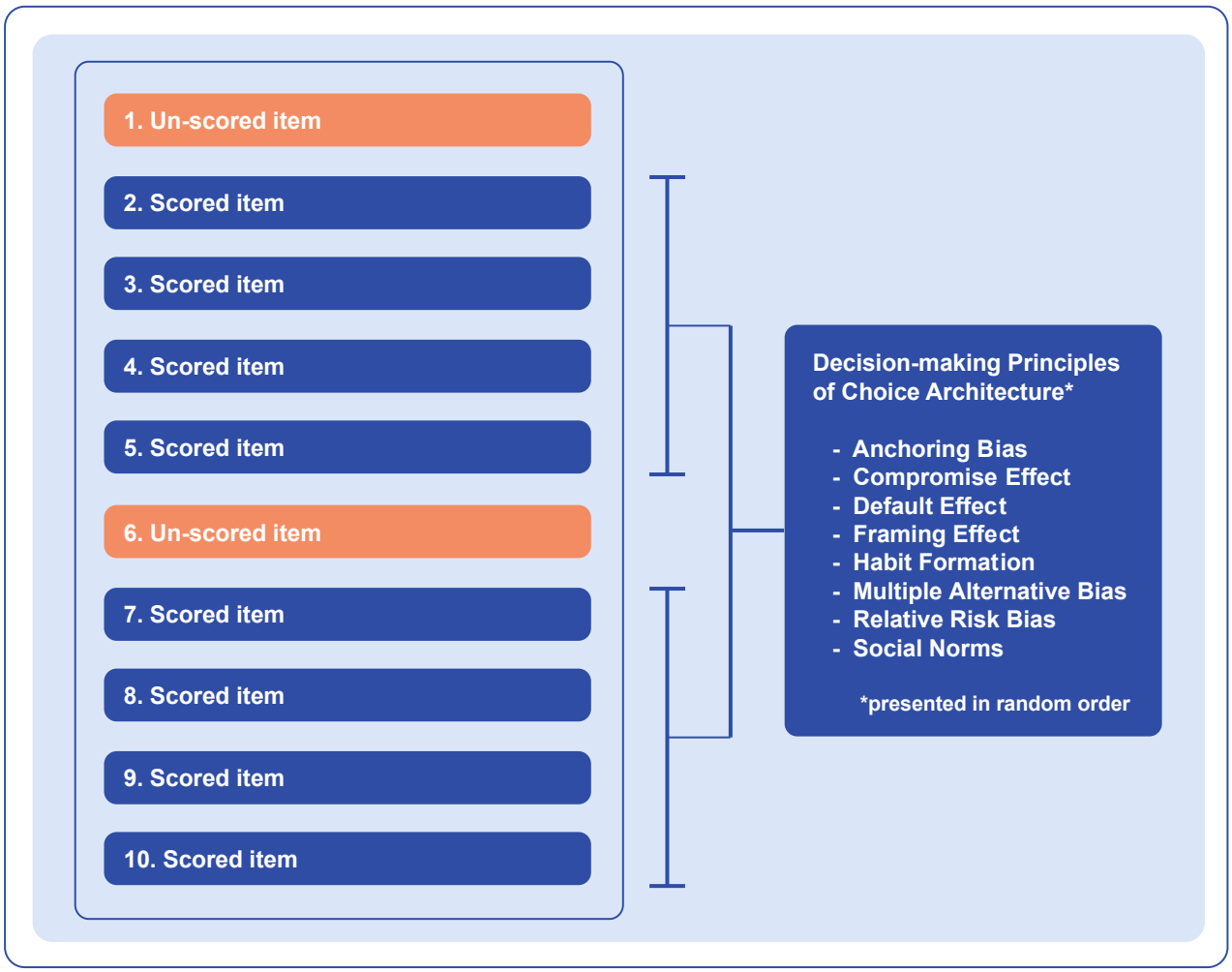
*p-value <0.05, where the frequency of Option A > Option B
**p-value <0.05, however, the frequency of Option A < Option B. Thus, the effect is in the wrong direction.

3B. Scenarios presented to two subgroups of MTurk Participants: Group 1 (n=135) and Group 2 (n=135)

Principle		Presentation 1	Presentation 2	p-value
		Option A	Option A	
Watchful Waiting vs. Active Surveillance	**n (%)**	102 (77%)	95 (70%)	>0.05
Compromise Effect		133 (100%)	63 (46%)	**<0.01***
Relative Risk Bias		113 (82%)	73 (55%)	**<0.001***
Framing Effect		91 (69%)	66 (48%)	**<0.001***
Overrepresentation Bias		87 (64%)	101 (75%)	>0.05
Multiple alternatives Bias		64 (49%)	41 (30%)	**<0.01***
Anchoring Bias	**mean (SD)****	39.1 (24.3)	32.5 (25.4)	**~~<~~0.0~~35~~***

*p-value <0.05, where the frequency or mean of Option A in Group 1 > Option A in Group 2.
**mean (SD) percent estimate of own risk was calculated because participants were asked to estimate their own risk, from 0-100%, of having a genetic disease after being anchored by a high (Group 1) or low (Group 2) number.

Appendix 5. Layout of scenario-based questions for physicians



Appendix 6. Scenario-based questions for physicians

Anchoring Bias

Scenario:
A woman at risk of a genetic disease is seeking medical advice.

Interaction 1:
While waiting, she is asked to write down the age of her youngest living relative.

Interaction 2:
While waiting, she is asked to write down the age of her oldest living relative.

At the start of the visit, you ask what her own estimated risk is before providing her with additional information. As compared to Interaction 1, Interaction 2 is likely to:

A. Increase her estimate of her own risk
B. Decrease her estimate of her own risk
C. Will not influence her estimate

Compromise Effect

Scenario:
Your patient has a medical condition that can be treated with medication.

Presentation 1:
As your physician, I recommend that you take one of these medications that will treat your medical condition.
Medication C: costs $90 per month after insurance, works SOME of the time but has FEW side effects.
Medication Q: costs $250 per month after insurance, works MOST of the time and has FEW side effects.

Presentation 2:
As your physician, I recommend that you take one of these medications that will treat your medical condition.
Medication C: costs $90 per month after insurance, works SOME of the time but has FEW side effects.
Medication Q: costs $250 per month after insurance, works MOST of the time and has FEW side effects.
Medication G: costs $500 per month after insurance, works ALMOST ALL of the time and has FEW side effects.

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Medication C
B. Medication Q
C. Does not influence the likelihood the patient will choose any specific option

Default Effect

Scenario:
Your patient needs a cardiology consultation. There are two physicians in the practice: Doctor A and Doctor B.

"The schedulers have set you up to see Doctor A. If you'd rather see Doctor B, just call this number and they will change your appointment for you."

This way of presenting options increases the likelihood that the patient will see:

A. Doctor A
B. Doctor B
C. Does not influence the likelihood the patient will choose any specific option

Framing Effect

Scenario:

You are presenting to the hospital administrator about a new outbreak of a disease. There are two proposed programs to combat this disease: Program A and Program B. You are the local expert in the unusual evidence base for these programs.

Presentation 1:

Program A: 25 out of 100 patients will be saved.
Program B: There is a 25% chance that all 100 patients will be saved and a 75% chance no patients will be saved.

Presentation 2

Program A: 75 out of 100 of the patients will die.
Program B: There is a 25% chance no patients will die and a 75% chance that all 100 patients will die.

As compared to Presentation 1, Presentation 2 increases the likelihood that the administrator will choose:

A. Program A
B. Program B
C. Does not influence the likelihood the patient will choose any specific option

Habit Formation

Scenario:

Your patient needs to take medication on a daily basis. As the patient's physician, there are two equally effective medication regimens. The risks and benefits of each option are identical.

Regimen A: Take one tablet daily
Regimen B: Take one tablet three days a week

Which regimen is more likely to support medication adherence?

A. Regimen A
B. Regimen B
C. Regimen A and Regimen B will have similar adherence

Multiple Alternatives Bias

Scenario:

Your patient has prostate cancer, for which there are multiple management options available. You describe the options available to the patient:

Presentation 1:

"You will need surgery to manage this cancer. You may also seek a second opinion"

Presentation 2:

"You will need either: laparoscopic surgery (a surgeon inserts cameras and tools through small skin incisions), robot-assisted surgery (a surgeon controls robotic arms through small skin incisions), or open surgery (a surgeon makes a single long skin incision). You may also seek a second opinion."

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Surgery
B. Second opinion
C. Does not influence the likelihood the patient will choose any specific option

Relative Risk Bias

Scenario:

You have a newly diagnosed lung cancer. As your physician, I recommend that you select either Procedure A or Procedure B. Both procedures are equally effective but have different risks. Both procedures are equally effective but have different risks.

Presentation 1:

Procedure A usually works and 20% of patients experience a complication.
Procedure B may work and 10% of patients experience a complication.

Presentation 2:

Procedure A usually works to solve the problem while Procedure B may work. Procedure A is twice as likely to cause a complication as Procedure B.

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Procedure A
B. Procedure B
C. Does not influence the likelihood that patient will choose either option.

Social Norms

Scenario:

Your patient needs to take an anticoagulation medication. There are two options available: Medications A and B.

"As your physician, I recommend one of two medications that are equally effective in thinning your blood. Medication A is a once-daily pill that requires regular blood tests. Medication B is a once-daily shot that you give yourself under your skin, but it does not require blood tests. Many of my patients put up with the blood tests."

This way of presenting options to the patient increases the likelihood that the patient will choose:

A. Medication A
B. Medication B
C. Does not influence the likelihood the patient will choose any specific option

Unscored item 1

Scenario:

A patient is selecting a new primary care physician. His insurance company's website provides the patient with two options, in no particular order:

Presentation 1:

Dr. P
Dr. K

Presentation 2:

Dr. P: $25 co-pay; 40 min travel time from patient's home address
Dr. K: $35 co-pay; 20 min travel time from patient's home address

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Dr. P
B. Dr. K
C. Does not influence the likelihood the patient will choose any specific option

Unscored Item 2

Scenario:

You have been appointed to the hospital's Healthy Eating Committee. You have been assigned the job of reducing the number of calories consumed per meal by cafeteria customers. You can choose one of two pilot programs that the administration will support:

Program 1:

Cafeteria customers may specifically request the cooks make high-calorie items such as pizza and hamburgers, but they will no longer be available as pre-made "grab and go" items.

Program 2:

Place the salad bar at the cafeteria entrance, so that all customers must walk past the salad bar offerings in order to reach the rest of the food choices.

Which program will result in greater calorie reductions among cafeteria customers' meals?

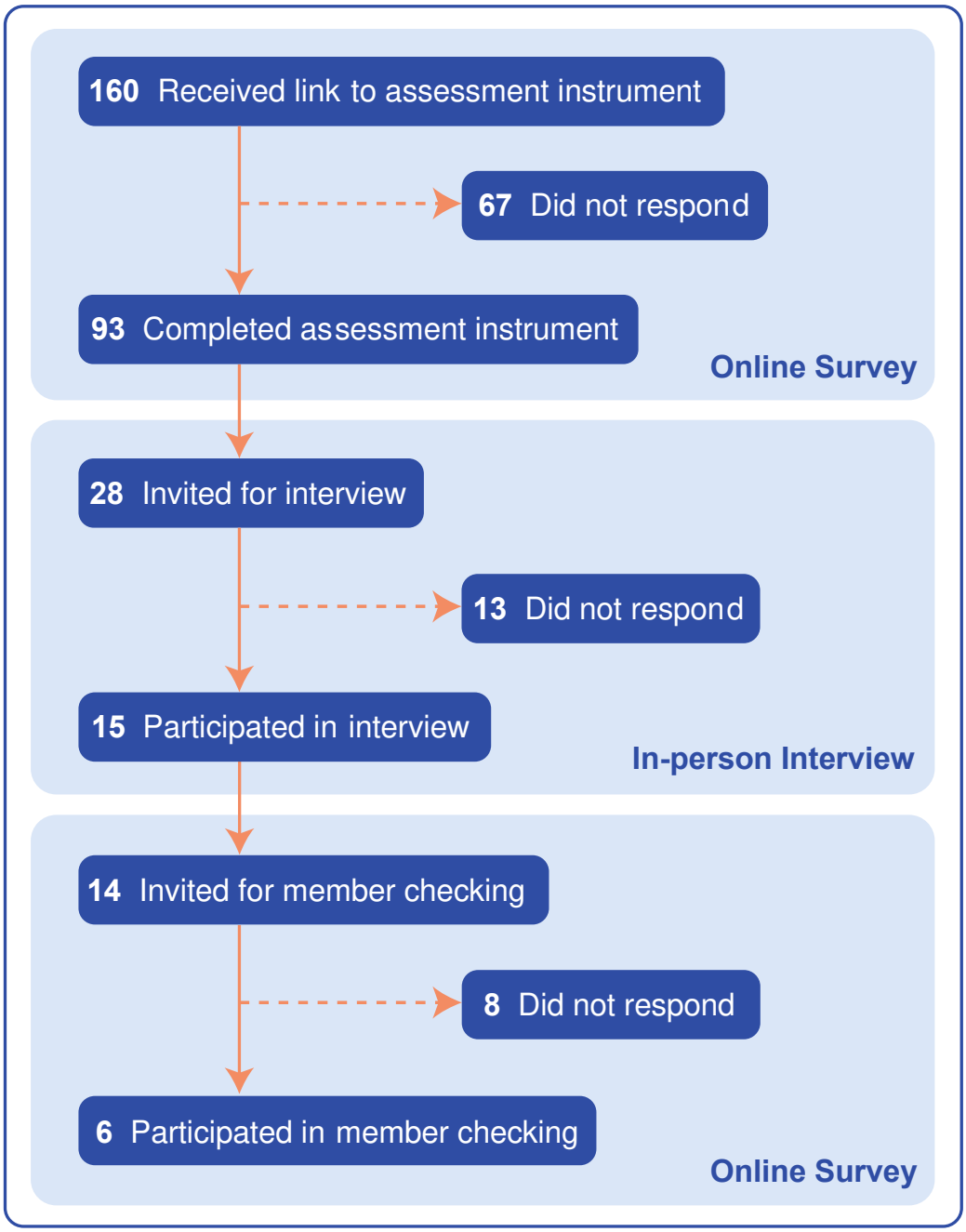
A. Program 1
B. Program 2
C. Programs 1 and 2 will result in a similar reduction in calories

Appendix 7. Association between physicians' characteristics and choice architecture competency

Characteristic	Estimate (95% CI)	*p*-value
Age		
Years	-0.03 (-0.14 – 0.08)	0.627
Gender		
Male	1.00	0.202
Female	-0.34 (-0.87 – 0.18)	
Race		
White	1.00	0.367
Black	0.70 (-0.78 – 2.18)	
Asian	-0.37 (-0.96 – 0.21)	
Other	-0.39 (-1.39 – 0.61)	
Ethnicity		
Non-Hispanic	1.00	0.865
Hispanic	0.15 (-1.64 – 1.95)	
Medical specialty		
Internal Medicine	1.00	0.275
Anesthesiology	-0.17 (-0.94 – 0.60)	
Emergency Medicine	-0.01 (-0.90 – 0.89)	
Surgery	0.11 (-0.75 – 0.97)	
Other	0.64 (-0.03 – 1.31)	
Political views		
Liberal	1.00	0.981
Conservative	0.13 (-0.96 – 1.23)	
Moderate	-0.05 (-0.62 – 0.52)	
Other	-0.20 (-1.70 – 1.31)	
Political party		
Democrat	1.00	0.571
Republican	0.33 (-0.47 – 1.12)	
Libertarian	0.49 (-0.99 – 1.98)	
Other	-0.28 (-0.98 – 0.43)	

ONLINE APPENDICES

Appendix 1. Flow diagram depicting the participation of resident physicians



Appendix 2. Scenario development

Decision-making principle: **Relative Risk Bias**

Scenario presented to online MTurk participants (randomly assigned to presentation 1 or 2)

Presentation 1:

You have a newly diagnosed lung cancer. As your physician, I recommend that you select either Procedure A or Procedure B. Both procedures are equally effective but have different risks. Procedure A usually works and 20% of patients experience a complication. Procedure B may work and 10% of patients experience a complication.

Which option will you choose?

A. Procedure A

B. Procedure B

*represents choice selected by the majority of MTurk users

-OR-

Presentation 2:

You have a newly diagnosed lung cancer. As your physician, I recommend that you select either Procedure A or Procedure B. Both procedures are equally effective but have different risks. Procedure A usually works to solve the problem while Procedure B may work. Procedure A is twice as likely to cause a complication as Procedure B.

Which option will you choose?

A. Procedure A

B. Procedure B*

*represents choice selected by the majority of MTurk users

Scenario presented to all resident physicians

Scenario: You have a newly diagnosed lung cancer. As your physician, I recommend that you select either Procedure A or Procedure B. Both procedures are equally effective but have different risks. Both procedures are equally effective but have different risks.

Presentation 1:

Procedure A usually works and 20% of patients experience a complication. Procedure B may work and 10% of patients experience a complication.

Presentation 2:

Procedure A usually works to solve the problem while Procedure B may work. Procedure A is twice as likely to cause a complication as Procedure B.

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Procedure A

B. Procedure B*

C. Does not influence the likelihood that patient will choose either option.

*represents correct answer based on prior literature and validation by MTurk users

Appendix 3. Characteristics of Amazon Mechanical Turk (MTurk) participants

Characteristic	
Sample Size	269
Age, mean (SD)	32.0 (10.3)
Gender, n (%)	
Male	101 (37.5%)
Female	168 (62.5%)
Race, n (%)	
White and/or Caucasian American	209 (77.7%)
Black and/or African American	17 (6.3%)
Asian and/or Asian American	11 (4.1%)
Other	32 (11.9%)
Ethnicity, n (%)	
Hispanic	25 (9.3%)
Non-Hispanic	244 (90.7%)
Education, n (%)	
None	1 (0.4%)
High school graduate or GED	99 (36.8%)
Some college, no degree	6 (2.2%)
Associate's degree	12 (4.5%)
Bachelor's degree	117 (43.5%)
Master's degree	26 (9.7%)
Doctorate or professional degree	8 (3.0%)
Employment status, n (%)	
Employed	179 (66.5%)
Self-employed	15 (5.6%)
Unemployed	20 (7.4%)
Stay-at-home parent	20 (7.4%)
Retired	6 (2.2%)
Student	29 (10.8%)

Appendix 4. Validation results from Amazon Mechanical Turk (MTurk)

3A. Scenarios presented to all MTurk Participants (n=269)

Principle				p-value
		Option A	Option B	
Default Effect	**n (%)**	249 (93%)	20 (7%)	**<0.001***
Endowment Effect		112 (42%)	157 (58%)	0.01**
Social Norms		195 (73%)	74 (27%)	**<0.01***

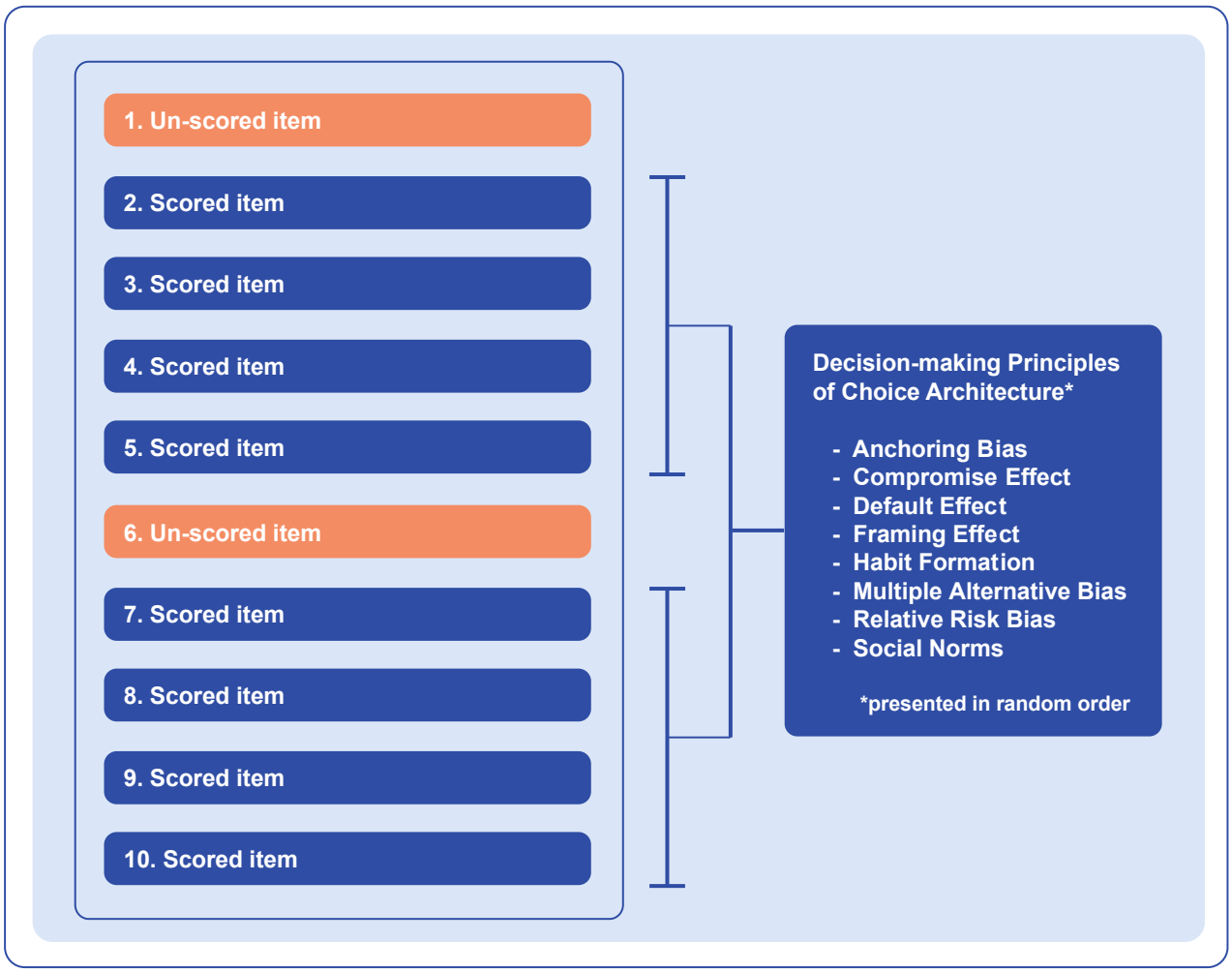
*p-value <0.05, where the frequency of Option A > Option B
**p-value <0.05, however, the frequency of Option A < Option B. Thus, the effect is in the wrong direction.

3B. Scenarios presented to two subgroups of MTurk Participants: Group 1 (n=135) and Group 2 (n=135)

Principle		Presentation 1	Presentation 2	p-value
		Option A	Option A	
Watchful Waiting vs. Active Surveillance	**n (%)**	102 (77%)	95 (70%)	>0.05
Compromise Effect		133 (100%)	63 (46%)	**<0.01***
Relative Risk Bias		113 (82%)	73 (55%)	**<0.001***
Framing Effect		91 (69%)	66 (48%)	**<0.001***
Overrepresentation Bias		87 (64%)	101 (75%)	>0.05
Multiple alternatives Bias		64 (49%)	41 (30%)	**<0.01***
Anchoring Bias	**mean (SD)****	39.1 (24.3)	32.5 (25.4)	**~~<~~0.0~~35~~***

*p-value <0.05, where the frequency or mean of Option A in Group 1 > Option A in Group 2.
**mean (SD) percent estimate of own risk was calculated because participants were asked to estimate their own risk, from 0-100%, of having a genetic disease after being anchored by a high (Group 1) or low (Group 2) number.

Appendix 5. Layout of scenario-based questions for physicians



Appendix 6. Scenario-based questions for physicians

Anchoring Bias

Scenario:
A woman at risk of a genetic disease is seeking medical advice.

Interaction 1:
While waiting, she is asked to write down the age of her youngest living relative.

Interaction 2:
While waiting, she is asked to write down the age of her oldest living relative.

At the start of the visit, you ask what her own estimated risk is before providing her with additional information. As compared to Interaction 1, Interaction 2 is likely to:

A. Increase her estimate of her own risk
B. Decrease her estimate of her own risk
C. Will not influence her estimate

Compromise Effect

Scenario:
Your patient has a medical condition that can be treated with medication.

Presentation 1:
As your physician, I recommend that you take one of these medications that will treat your medical condition.
Medication C: costs $90 per month after insurance, works SOME of the time but has FEW side effects.
Medication Q: costs $250 per month after insurance, works MOST of the time and has FEW side effects.

Presentation 2:
As your physician, I recommend that you take one of these medications that will treat your medical condition.
Medication C: costs $90 per month after insurance, works SOME of the time but has FEW side effects.
Medication Q: costs $250 per month after insurance, works MOST of the time and has FEW side effects.
Medication G: costs $500 per month after insurance, works ALMOST ALL of the time and has FEW side effects.

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Medication C
B. Medication Q
C. Does not influence the likelihood the patient will choose any specific option

Default Effect

Scenario:
Your patient needs a cardiology consultation. There are two physicians in the practice: Doctor A and Doctor B.

"The schedulers have set you up to see Doctor A. If you'd rather see Doctor B, just call this number and they will change your appointment for you."

This way of presenting options increases the likelihood that the patient will see:

A. Doctor A
B. Doctor B
C. Does not influence the likelihood the patient will choose any specific option

Framing Effect

Scenario:

You are presenting to the hospital administrator about a new outbreak of a disease. There are two proposed programs to combat this disease: Program A and Program B. You are the local expert in the unusual evidence base for these programs.

Presentation 1:

Program A: 25 out of 100 patients will be saved.
Program B: There is a 25% chance that all 100 patients will be saved and a 75% chance no patients will be saved.

Presentation 2

Program A: 75 out of 100 of the patients will die.
Program B: There is a 25% chance no patients will die and a 75% chance that all 100 patients will die.

As compared to Presentation 1, Presentation 2 increases the likelihood that the administrator will choose:

A. Program A
B. Program B
C. Does not influence the likelihood the patient will choose any specific option

Habit Formation

Scenario:

Your patient needs to take medication on a daily basis. As the patient's physician, there are two equally effective medication regimens. The risks and benefits of each option are identical.

Regimen A: Take one tablet daily
Regimen B: Take one tablet three days a week

Which regimen is more likely to support medication adherence?

A. Regimen A
B. Regimen B
C. Regimen A and Regimen B will have similar adherence

Multiple Alternatives Bias

Scenario:

Your patient has prostate cancer, for which there are multiple management options available. You describe the options available to the patient:

Presentation 1:

"You will need surgery to manage this cancer. You may also seek a second opinion"

Presentation 2:

"You will need either: laparoscopic surgery (a surgeon inserts cameras and tools through small skin incisions), robot-assisted surgery (a surgeon controls robotic arms through small skin incisions), or open surgery (a surgeon makes a single long skin incision). You may also seek a second opinion."

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Surgery
B. Second opinion
C. Does not influence the likelihood the patient will choose any specific option

Relative Risk Bias

Scenario:

You have a newly diagnosed lung cancer. As your physician, I recommend that you select either Procedure A or Procedure B. Both procedures are equally effective but have different risks. Both procedures are equally effective but have different risks.

Presentation 1:

Procedure A usually works and 20% of patients experience a complication.
Procedure B may work and 10% of patients experience a complication.

Presentation 2:

Procedure A usually works to solve the problem while Procedure B may work. Procedure A is twice as likely to cause a complication as Procedure B.

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Procedure A
B. Procedure B
C. Does not influence the likelihood that patient will choose either option.

Social Norms

Scenario:

Your patient needs to take an anticoagulation medication. There are two options available: Medications A and B.

"As your physician, I recommend one of two medications that are equally effective in thinning your blood. Medication A is a once-daily pill that requires regular blood tests. Medication B is a once-daily shot that you give yourself under your skin, but it does not require blood tests. Many of my patients put up with the blood tests."

This way of presenting options to the patient increases the likelihood that the patient will choose:

A. Medication A
B. Medication B
C. Does not influence the likelihood the patient will choose any specific option

Unscored item 1

Scenario:

A patient is selecting a new primary care physician. His insurance company's website provides the patient with two options, in no particular order:

Presentation 1:

Dr. P
Dr. K

Presentation 2:

Dr. P: $25 co-pay; 40 min travel time from patient's home address
Dr. K: $35 co-pay; 20 min travel time from patient's home address

As compared to Presentation 1, Presentation 2 increases the likelihood that the patient will choose:

A. Dr. P
B. Dr. K
C. Does not influence the likelihood the patient will choose any specific option

Unscored Item 2

Scenario:

You have been appointed to the hospital's Healthy Eating Committee. You have been assigned the job of reducing the number of calories consumed per meal by cafeteria customers. You can choose one of two pilot programs that the administration will support:

Program 1:

Cafeteria customers may specifically request the cooks make high-calorie items such as pizza and hamburgers, but they will no longer be available as pre-made "grab and go" items.

Program 2:

Place the salad bar at the cafeteria entrance, so that all customers must walk past the salad bar offerings in order to reach the rest of the food choices.

Which program will result in greater calorie reductions among cafeteria customers' meals?

A. Program 1
B. Program 2
C. Programs 1 and 2 will result in a similar reduction in calories

Appendix 7. Association between physicians' characteristics and choice architecture competency

Characteristic	Estimate (95% CI)	*p*-value
Age		
Years	-0.03 (-0.14 – 0.08)	0.627
Gender		
Male	1.00	0.202
Female	-0.34 (-0.87 – 0.18)	
Race		
White	1.00	0.367
Black	0.70 (-0.78 – 2.18)	
Asian	-0.37 (-0.96 – 0.21)	
Other	-0.39 (-1.39 – 0.61)	
Ethnicity		
Non-Hispanic	1.00	0.865
Hispanic	0.15 (-1.64 – 1.95)	
Medical specialty		
Internal Medicine	1.00	0.275
Anesthesiology	-0.17 (-0.94 – 0.60)	
Emergency Medicine	-0.01 (-0.90 – 0.89)	
Surgery	0.11 (-0.75 – 0.97)	
Other	0.64 (-0.03 – 1.31)	
Political views		
Liberal	1.00	0.981
Conservative	0.13 (-0.96 – 1.23)	
Moderate	-0.05 (-0.62 – 0.52)	
Other	-0.20 (-1.70 – 1.31)	
Political party		
Democrat	1.00	0.571
Republican	0.33 (-0.47 – 1.12)	
Libertarian	0.49 (-0.99 – 1.98)	
Other	-0.28 (-0.98 – 0.43)	