

ISSN 1936-5349 (print)  
ISSN 1936-5357 (online)

# HARVARD

JOHN M. OLIN CENTER FOR LAW, ECONOMICS, AND BUSINESS

BOUNDEDLY RATIONAL PATIENTS?  
HEALTH AND PATIENT MISTAKES IN A BEHAVIORAL FRAMEWORK

Ada C. Stefanescu Schmidt  
Ami Bhatt  
Cass R. Sunstein

Discussion Paper No. 925

06/2017

Harvard Law School  
Cambridge, MA 02138

This paper can be downloaded without charge from:

The Harvard John M. Olin Discussion Paper Series:  
[http://www.law.harvard.edu/programs/olin\\_center](http://www.law.harvard.edu/programs/olin_center)

The Social Science Research Network Electronic Paper Collection:  
<https://ssrn.com/abstract=2953250>

## **Boundedly Rational Patients? Health and Patient Mistakes in a Behavioral Framework**

Ada C. Stefanescu Schmidt,\* Ami B. Bhatt,\*\* Cass R. Sunstein\*\*\*

### **Abstract**

*During medical visits, the stakes are high for many patients, who are put in a position to make, or to begin to make, important health-related decisions. But in such visits, patients often make cognitive errors. Traditionally, those errors are thought to result from poor communication with physicians; complicated subject matter; and patient anxiety. To date, measures to improve patient understanding and recall have had only modest effects. This paper argues that an understanding of those cognitive errors can be improved by reference to a behavioral science framework, which distinguishes between a “System 1” mindset, in which patients are reliant on intuition and vulnerable to biases and imperfectly reliable heuristics, and a “System 2” mindset, which is reflective, slow, deliberative, and detailed-oriented. To support that argument, we present the results of a randomized-assignment experiment that shows that patients perform very poorly on the Cognitive Reflection Test and thus are overwhelmingly in a System 1 state prior to a physician visit. Assigning patients the task of completing patient-reported outcomes measures immediately prior to the visit had a small numerical, but not statistically significant, shift towards a reflective frame of mind. We describe hypotheses to explain poor performance by patients, which may be due to anxiety, a bandwidth tax, or a scarcity effect, and outline further direction for study. Understanding the behavioral sources of errors on the part of patients in their interactions with physicians and in their decision-making is necessary to implement measures improve shared decision-making, patient experience, and (perhaps above all) clinical outcomes.*

### **I. Introduction**

#### **A. Cognitive Challenges in Health Care**

---

\* Clinical and Research Fellow, Division of Cardiology, Massachusetts General Hospital and Harvard Medical School

\*\* Director, Outpatient Cardiology, Massachusetts General Hospital

\*\*\* Robert Walmsley University Professor, Harvard University.

The relationship between patient and physician has much changed in the last century, with a shift from paternalistic to shared decision-making, loss of longitudinal relationships, increase in volumes and shorter visit times.

Understanding the factors that govern this relationship is crucial in improving the experience of patients – and also clinical outcomes. As patient-centered decision-making has become closer to a science, many evidence-based improvements in the communication methods of providers have been made. To date, however, the frame of mind of patients and methods to enhance both the quality and quantity of their involvement in their own care has not been the target of interventions.

In their landmark report “To Err is Human: Building a Safer Health System”, the Institute of Medicine estimated that preventable medical errors are responsible for more deaths annually than motor vehicle accidents, breast cancer, and AIDS<sup>1</sup>. An important cause of those errors is lapses in patient-provider communication, which can lead to errors in diagnosis, testing, and treatment strategy. In addition to the quality of the communication from patient to physician and vice-versa, the patients’ understanding of new medical information and recall of relevant information, during and after the visit, present cognitive challenges during which mistakes are commonly made. There are several distinct problems, all of which can be connected with continuing work in behavioral science.

First, errors in understanding of statistics lead to misdirection and poor decision-making by patients. Patients have been documented to overestimate their chance of survival and underestimate their personal risk of complications, even

---

<sup>1</sup> Linda T. Kohn, Janet Corrigan, and Molla S. Donaldson, *To Err Is Human : Building a Safer Health System* (Washington, D.C.: National Academy Press, 2000).

when accurately estimating the risk of others<sup>2</sup>. Patients have difficulty understanding their likelihood of cancer when given the real-life results of a test and false positive rate- strikingly, so do their doctors<sup>3</sup>. Framing of the benefits versus risks avoided by preventative health measures can have a large impact<sup>4</sup>. Even seemingly crucial and very personal decisions such as end-of-life decisions<sup>5</sup> and organ donation registration<sup>6</sup> can be influenced by the way the question is framed<sup>7</sup>. Cognitive errors on the part of patients are frequent and seen in both inpatient and outpatient sessions, across socioeconomic classes and education levels, although with greater magnitude in less educated and older patients.

These errors in understanding medical information have been blamed on the inherently complicated subject matter; low rates of medical literacy; poor communication from the physicians; and pressure from lack of time and high emotional burden. In response, studies have been done to correct those

---

<sup>2</sup> J. C. Weeks et al., "Relationship between Cancer Patients' Predictions of Prognosis and Their Treatment Preferences," *JAMA* 279, no. 21 (1998).

<sup>3</sup> G. Gigerenzer and A. Edwards, "Simple Tools for Understanding Risks: From Innumeracy to Insight," *BMJ* 327, no. 7417 (2003).

<sup>4</sup> D. Sarfati et al., "Does the Frame Affect the Picture? A Study into How Attitudes to Screening for Cancer Are Affected by the Way Benefits Are Expressed," *J Med Screen* 5, no. 3 (1998).

<sup>5</sup> L. M. Kressel and G. B. Chapman, "The Default Effect in End-of-Life Medical Treatment Preferences," *Med Decis Making* 27, no. 3 (2007); L. M. Kressel, G. B. Chapman, and E. Leventhal, "The Influence of Default Options on the Expression of End-of-Life Treatment Preferences in Advance Directives," *J Gen Intern Med* 22, no. 7 (2007). S. D. Halpern et al., "Default Options in Advance Directives Influence How Patients Set Goals for End-of-Life Care," *Health Aff (Millwood)* 32, no. 2 (2013).

<sup>6</sup> Ways in which patients are influenced when making those decisions reviewed in Richard H. Thaler and Cass R. Sunstein, *Nudge: Improving Decisions About Health, Wealth, and Happiness*, Rev. and expanded ed. (New York: Penguin Books, 2009).

<sup>7</sup> An argument can be made that on both these topics, patients are generally very poorly informed, and do not like thinking about the choices they can make and their implications; they tend to choose quickly and are particularly easy to influence, in clinical experience and in studies, by defaults or outside advice.

externalities, sometimes with positive results. Tools to help understanding of statistics, such as simpler and more descriptive language (“Out of 100 people with your disease, 3 will have a stroke or die in the next year if they don’t take their blood thinning medication”, instead of “The risk of stroke or death is 3%/year”) have been shown to improve understanding<sup>8</sup>, especially if accompanied by simple graphical representations<sup>9</sup>. Use of written materials and decision aids has increased short-term patient recall of information, satisfaction, and participation in decision-making<sup>10</sup>, although not anxiety related to consent for a procedure<sup>11</sup>.

Second, patients have poor recall of information prior to, during, and after a medical interaction. The most “savvy” of patients- even physicians, when they are themselves patients- often remember the one thing they meant to ask their doctor only at the end of the visit- “the doorknob question”, in medical jargon- or, worse, on the way home. Recall by patients of timing of health-related events, especially those with emotional salience, is poor<sup>12</sup>. Recall of information given during a medical visit

---

<sup>8</sup> Daniel Kahneman, *Thinking, Fast and Slow*, 1st pbk. ed. (New York: Farrar, Straus and Giroux, 2013).

<sup>9</sup> J. A. Spertus et al., "Precision Medicine to Improve Use of Bleeding Avoidance Strategies and Reduce Bleeding in Patients Undergoing Percutaneous Coronary Intervention: Prospective Cohort Study before and after Implementation of Personalized Bleeding Risks," *BMJ* 350 (2015).

<sup>10</sup> E. P. Hess et al., "The Chest Pain Choice Decision Aid: A Randomized Trial," *Circ Cardiovasc Qual Outcomes* 5, no. 3 (2012). for choice of tests and risk of radiation vs. cardiovascular event in patients with low-risk chest pain, and J. F. Waljee, M. A. Rogers, and A. K. Alderman, "Decision Aids and Breast Cancer: Do They Influence Choice for Surgery and Knowledge of Treatment Options?," *J Clin Oncol* 25, no. 9 (2007). in choice of medical versus surgical treatment of breast cancer. See D. Stacey et al., "Decision Aids for People Facing Health Treatment or Screening Decisions," *Cochrane Database Syst Rev* 1 (2014). for recent Cochrane review of evidence base for decision aid tools in medicine.

<sup>11</sup> P. Kinnersley et al., "Interventions to Promote Informed Consent for Patients Undergoing Surgical and Other Invasive Healthcare Procedures," *ibid.* 7 (2013).

<sup>12</sup> Lisa M. Hess et al., "Patient Recall of Health Care Events and Time to Diagnose a Suspected Ovarian Cancer," *Clinical Ovarian & Other Gynecologic Cancer* 5, no. 1..

is generally estimated to be less than half of what was discussed, even in healthy volunteers when given unstructured discharge information<sup>13</sup>. Studies have shown a poor correlation between what patients and healthcare professionals remember from one visit. In one study, 45% of pairs remembered different goals as having been set during the visit, and 21% did not think the same decisions were reached<sup>14</sup>. Similarly to the challenges in understanding medical information, efforts to simplify information and improve the communication have been studied, with some improvement in recall. Use of written or pictorial end-of-visit summaries has been proposed as a way to increase recall of instructions, with especially promising results in one study, improving recall from 14% to 85%<sup>15</sup>.

Patient-reported outcomes measures (PROMs) were proposed in the last two decades as a way to increase patient involvement, improve recall, and focus care on elements that are important for quality of life<sup>16</sup>. PROMs consist of detailed symptom surveys given to patients prior to visits. By asking questions about specific symptoms, periods of time and quality of life spheres, they are thought to improve recall and reporting of symptoms by patients. For instance, heart failure PROMs such as the Kansas City Cardiomyopathy Questionnaire ask patients about their shortness of breath over the last two weeks, as noticed when walking, climbing

---

<sup>13</sup> Wolf Langewitz et al., "Improving Patient Recall of Information: Harnessing the Power of Structure," *Patient Education and Counseling* 98, no. 6 (2015).

<sup>14</sup> T. Parkin and T. C. Skinner, "Discrepancies between Patient and Professionals Recall and Perception of an Outpatient Consultation," *Diabet Med* 20, no. 11 (2003).

<sup>15</sup> P. S. Houts et al., "Using Pictographs to Enhance Recall of Spoken Medical Instructions," *Patient Educ Couns* 35, no. 2 (1998).

<sup>16</sup> J. H. Wasson et al., "A Randomized Trial of the Use of Patient Self-Assessment Data to Improve Community Practices," *Eff Clin Pract* 2, no. 1 (1999). and E. C. Nelson et al., "Patient Reported Outcome Measures in Practice," *BMJ* 350 (2015).

stairs, showering, hurrying on the street<sup>17</sup>. They are increasingly used and helping in focusing the discussion during the patient visit, tracking symptom changes after an intervention, and as endpoints in clinical trials.

While inherently complicated medical information and poor communication have been shown to play a role in causing patient errors, and some improvements in understanding and outcomes have been seen with interventions in those domains, less attention has been given to the effects on patients of the biases and heuristics that have been shown to cause cognitive errors in other settings- buying a car, choosing insurance, saving for retirement.

### **B. Cognitive challenges in real life- and their effects in healthcare**

In an influential essay, Stanovich and West<sup>18</sup> describe two families of cognitive operations: “System 1”, an intuitive, fast-thinking system, that use heuristics, and “System 2”, a slow-thinking, deliberate, effortful system that is used for complex reasoning. Taking the idea of two systems as a metaphor, Kahneman has elaborated their differences and interactions, describing the benefits of System 1 thought (rapid retrieval of memories and information, short reaction time) as well as its costs (such as biases, error-prone heuristics, and susceptibility to framing and anchoring). For instance, most of us have a poor intuitive understanding of

---

<sup>17</sup> J. A. Spertus and P. G. Jones, "Development and Validation of a Short Version of the Kansas City Cardiomyopathy Questionnaire," *Circ Cardiovasc Qual Outcomes* 8, no. 5 (2015).

<sup>18</sup> K. E. Stanovich and R. F. West, "Individual Differences in Reasoning: Implications for the Rationality Debate?," *Behav Brain Sci* 23, no. 5 (2000).

statistics<sup>19</sup> and are influenced by framing effects and status quo bias, which can lead us to make poor choices in long-term economic decisions such as saving for retirement and choosing loan programs<sup>20</sup>. In the healthcare field, poor adherence to medications in patients in low socioeconomic classes can be better understood in light of the fact that because of poverty, they have limited bandwidth for attention to health, in particular of long-term consequences of diseases with few or non current symptoms, such as hypertension or diabetes<sup>21</sup>.

An understanding of behavioral biases<sup>22</sup> is increasingly being used to set policy – not only at the level of government but also by private institutions, including in the domains of health and medicine. For example, lessons from behavioral economics have recently been applied in population health management<sup>23</sup>. The applications have generally shown benefits in short trials,

---

<sup>19</sup> see Tversky and Kahneman's seminal work in A. Tversky and D. Kahneman, "The Framing of Decisions and the Psychology of Choice," *Science* 211, no. 4481 (1981); "Judgment under Uncertainty: Heuristics and Biases," *Science* 185, no. 4157 (1974). and Daniel Kahneman and Amos Tversky, "Prospect Theory: An Analysis of Decision under Risk," *Econometrica* 47, no. 2 (1979).

<sup>20</sup> Cass R. Sunstein, "Deciding by Default," *University of Pennsylvania Law Review* (2013).

<sup>21</sup> Sendhil Mullainathan and Eldar Shafir, *Scarcity: Why Having Too Little Means So Much*, First edition. ed. (New York: Times Books, Henry Holt and Company, 2013).

<sup>22</sup> Thaler and Sunstein, *Nudge: Improving Decisions About Health, Wealth, and Happiness*.

<sup>23</sup> See P. A. Ubel, D. A. Comerford, and E. Johnson, "Healthcare.Gov 3.0--Behavioral Economics and Insurance Exchanges," *N Engl J Med* 372, no. 8 (2015)., for choices of health insurance; D. E. Levy et al., "Food Choices of Minority and Low-Income Employees: A Cafeteria Intervention," *Am J Prev Med* 43, no. 3 (2012); L. Sonnenberg et al., "A Traffic Light Food Labeling Intervention Increases Consumer Awareness of Health and Healthy Choices at the Point-of-Purchase," *Prev Med* 57, no. 4 (2013); A. N. Thorndike et al., "Traffic-Light Labels and Choice Architecture: Promoting Healthy Food Choices," *Am J Prev Med* 46, no. 2 (2014); A. N. Thorndike, J. Riis, and D. E. Levy, "Social Norms and Financial Incentives to Promote Employees' Healthy Food Choices: A Randomized Controlled Trial," *Prev Med* 86 (2016). for interventions to improve dietary patterns; E. L. Merrick et al., "Testing Novel Patient Financial Incentives to Increase Breast Cancer Screening," *Am J Manag Care* 21, no. 11 (2015). to increase the rates of cancer screening; and M. S. Patel et al., "Premium-Based Financial Incentives Did Not Promote Workplace Weight Loss in a 2013-15 Study," *Health*



although there is not yet solid evidence for lasting benefits. Interventions that influence both patients and physicians have been recently studied, such as an evidence-based risk calculator to be performed in real time by the physician at the patient's bedside, which was shown to significantly reduce the risk of complications in coronary angiography<sup>24</sup>.

At the same time, the effects of biases and heuristics on healthcare at the level of the patient-physician interaction and the individual medical visit have yet to be studied in any detail. We would expect System 1 thinking to be especially prominent during a visit, when patients are under pressure, short of time, and obliged to make quick decisions. This claim can elegantly explain some or perhaps all of the cognitive errors faced by patients described earlier: System 1 relies on intuition for statistics, producing a high error rate<sup>25</sup>; it is dependent on context and recent memories have more salience, which is why patients give more salience to recent symptoms rather than accurately describing their history; it is impulsive and discounts the future in favor of the present, which can lead to poor and regretted long-term medical decisions, especially in end-of-life care; it is optimistic and overconfident, as seen in patients' underestimation of their personal risk for adverse events when compared to the general population.

---

*Aff (Millwood)* 35, no. 1 (2016); M. S. Patel et al., "Framing Financial Incentives to Increase Physical Activity among Overweight and Obese Adults: A Randomized, Controlled Trial of Financial Incentives for Physical Activity in Overweight and Obese Adults," *Annals of Internal Medicine* (2016), for physical activity and weight loss

<sup>24</sup> Spertus et al., "Precision Medicine to Improve Use of Bleeding Avoidance Strategies and Reduce Bleeding in Patients Undergoing Percutaneous Coronary Intervention: Prospective Cohort Study before and after Implementation of Personalized Bleeding Risks."

<sup>25</sup> Kahneman, *Thinking, Fast and Slow*.

While the factors affecting patient decision-making have been less studied than physician decision-making, there is evidence that even highly educated patients- in a striking example, economists well versed in statistics and probability- rely on heuristics rather than the available evidence base, even when offered to them<sup>26</sup>. Cognitive aging has been found to be associated with more reliance on heuristics outside of the healthcare setting<sup>27</sup>. System 2, on the other hand, would be expected to be lead to more detailed thought, better understanding of complex information, and better recall of information. The shift between one system and the other usually occurs unconsciously, as a response to outside stimuli (such as tasks that present a cognitive load, such as complicated multiplications or reading difficult handwriting), or emotions (sadness, for instance)<sup>28</sup>. While the frame of mind of humans in many scenarios has been tested, it has not, to our knowledge, been empirically examined for patients in a healthcare setting.

### C. Study Hypotheses

---

<sup>26</sup> N. Berg, G. Biele, and G. Gigerenzer, "Does Consistency Predict Accuracy of Beliefs? Economists Surveyed About Psa," (2010).; see J. N. Marewski and G. Gigerenzer, "Heuristic Decision Making in Medicine," *Dialogues Clin Neurosci* 14, no. 1 (2012). for a review of data on physician and patients heuristics. C. B. Renjilian et al., "Parental Explicit Heuristics in Decision-Making for Children with Life-Threatening Illnesses," *Pediatrics* 131, no. 2 (2013). identified common heuristics in interviews with parents of critically ill children in the hospital.

<sup>27</sup> R. Mata, L. J. Schooler, and J. Rieskamp, "The Aging Decision Maker: Cognitive Aging and the Adaptive Selection of Decision Strategies," *Psychol Aging* 22, no. 4 (2007); T. Pachur, R. Mata, and L. J. Schooler, "Cognitive Aging and the Adaptive Use of Recognition in Decision Making," *ibid.* 24 (2009).

<sup>28</sup> Kahneman, *Thinking, Fast and Slow.*: Interestingly, even invoking an emotion subconsciously can have a strong effect: in one experiment, subjects were instructed to hold a pencil in their mouth in a position that made them frown. They subsequently had higher, more "System 2" scores, on a test.

We hypothesize that the majority of patients are in a fast-thinking, intuitive System 1 frame of mind before, and during a visit with their physician, which is associated with anxiety or nervousness. As a secondary hypothesis, the administration of a cognitively heavy task, such as a PROM tool, will shift patients to a System 2 frame. We emphasize that we report here a pilot study, meant to provide preliminary evidence on the issues that concern us.

## **II. Methods**

### **A. Patient population**

We performed a randomized assignment study of patients from the Massachusetts General Hospital Adult Congenital Heart Disease clinic. Patients over the age of 18 and able to independently fill the questionnaire and who consented to participate were enrolled in the study. Patients were randomly assigned to the order in which they completed the study surveys before seeing their physician: the control group was first given the Cognitive Reflection Test (CRT), and the intervention group was given the PROMs first.

### **B. Survey tools**

The CRT is a three-question tool designed by Frederick to assess frame of mind (Figure 1) <sup>29</sup>. The questions are simple mathematical problems that have an intuitive but incorrect answer. Importantly, subjects with low scores on the test

---

<sup>29</sup> Shane Frederick, "Cognitive Reflection and Decision Making," *Journal of Economic Perspectives* 19, no. 4 (2005).

have not only been shown to be in a System 1 frame of mind, but also to exhibit typical System 1 behaviors, such as higher impulsivity, less self-control, and higher discounting of future value<sup>30</sup>.

The PROMs tools are used in routine clinical practice to assess patient symptoms and impact on their quality of life. They are typically given to patients to complete prior to a physician encounter, to help set a starting point for the discussion, as well as provide an objective value (a symptom score, usually on a scale of 0-100) that can be followed over time. In the MGH adult congenital heart disease clinic, patients are given the Kansas City Cardiomyopathy Questionnaire<sup>31</sup> (KCCQ; Figure 2), Patient-Reported Outcomes Measurement Information System<sup>32,33</sup> (PROMIS-10; Figure 3) and Patient Health Questionnaire-2<sup>34</sup> (PHQ2; Figure 4) questionnaires.

The KCCQ was designed and validated to assess symptoms of heart failure by asking activity-specific questions; it correlates both with other measures of symptoms and with the rate of hospitalizations, morbidity and mortality from heart failure. The PROMIS tool was developed by the National Institutes of Health as a tool to assess general health status and quality of life; it contains questions on both

---

<sup>30</sup> idem

<sup>31</sup> Spertus and Jones, "Development and Validation of a Short Version of the Kansas City Cardiomyopathy Questionnaire."

<sup>32</sup> D. Cella et al., "The Patient-Reported Outcomes Measurement Information System (Promis): Progress of an Nih Roadmap Cooperative Group During Its First Two Years," *Med Care* 45, no. 5 Suppl 1 (2007).

<sup>33</sup> N. E. Rothrock et al., "Relative to the General Us Population, Chronic Diseases Are Associated with Poorer Health-Related Quality of Life as Measured by the Patient-Reported Outcomes Measurement Information System (Promis)," *J Clin Epidemiol* 63, no. 11 (2010).

<sup>34</sup> K. Kroenke, R. L. Spitzer, and J. B. Williams, "The Patient Health Questionnaire-2: Validity of a Two-Item Depression Screener," *Med Care* 41, no. 11 (2003).

mental and physical state. The PHQ-2 is a short form version of the Patient Health Questionnaire depression module, and was validated as a good screening tool for depression by evaluating frequency of depressed mood and anhedonia.

The PROMs surveys were administered on an electronic validated platform (Tonic Health, Menlo Park, CA). After their visit and prior to leaving the clinic, patients filled a post-visit survey, where they ranked their subjective recall of their questions and information the physician gave them on a Likert scale (from “completely disagree” to “completely agree”; Figure 5), as well as their assessment of their level of anxiety or nervousness before the visit. They also self-identified their first language and education level. Medical records were reviewed for demographics, diagnosis, and disease severity. Since the survey answers were deidentified, consent was given by patients verbally after receiving information about the study. The study was approved by the Massachusetts General Hospital Institutional Review Board.

### **C. Primary Endpoint**

The primary endpoint was the mean CRT score in the complete study population. Secondary endpoints were the comparison between the CRT score distribution between the two randomized groups, the correlation between CRT scores and subjective reports of pre-visit anxiety and recall of information given by the physician.

### **D. Statistical Analysis**

Student's Ttest was used to compare normally distributed continuous variables; Fisher's exact test was used to compare non-normally distributed categorical variables. Spearman's correlation was used to assess the relationship among the CRT score, baseline reported anxiety score, and end of visit self-reported recall. Target sample size was estimated at 22 patients in each group to detect a difference in CRT score of 1 point of greater, with a standard deviation of scores of 1, based on the prior published results of the CRT with 90% power (alpha 0.05)<sup>35,36</sup>.

### **III. Results**

#### **A. Patient population**

Forty-seven patients participated, with mean age of 47.7 (SD 20; baseline demographics presented in Table 1). The large majority of patients reported English as their first language (93%). All had completed high school (94% at least started college). The majority of patient appointments were for routine follow-ups or new patient visits; no urgent care appointments were included.

#### **B. CRT scores**

The median CRT score was 0 (interquartile range 0-1; Figure 6). Over two-thirds of patients in either group had a score of 0 (80% in the group randomized to the CRT first, and 68% in the group randomized to PROMs first). The overwhelming majority of wrong answers (71%) were the intuitive answers expected on the CRT

---

<sup>35</sup> Frederick, "Cognitive Reflection and Decision Making."

<sup>36</sup> Guillermo Campitelli and Martin Labollita, "Correlations of Cognitive Reflection with Judgments and Choices," *Judgment and Decision Making* 5, no. 3 (2010).

(10 cents, 100 minutes, and 24 days); 23 of the 35 subjects with a score of 0 had answered the intuitive answer to all three questions. The mean score was 0.45 (SD 0.86). Notably, that is significantly lower than previously published results in control populations, where the mean scores varied from 0.57 to 2.18, in 35 studies with a total of 3428 respondents<sup>37</sup>.

CRT scores were numerically higher in the group who completed the PROMs first, but the difference in score distribution was not statistically different (Figure 6,  $p=0.46$ ; mean 0.50 vs. 0.40). The correlation between CRT scores and self-report of nervousness was low (Spearman's  $r= -0.14$ ). There was a trend towards higher mean CRT scores in the patients who reported feeling depressed or anxious "sometimes" or "often" (0.85 +/- 1.1 vs. 0.37 +/- 0.8,  $p=0.17$ ).

### **C. PROMs results**

Patients reported generally a low to moderate symptom burden, with a mean KCCQ-12 symptom rating of 85.6 out of 100 (SD 17.5), and reported high quality of life (mean score 82.8, SD 26.8) and low to no limitation of their social life by their heart failure (mean score 85.4, SD 22.6). There were no significant differences in scores between the two randomized groups.

A significant proportion of patients reported feeling anxious or depressed, with 18% scoring 3 or higher on the PHQ-2 scale, and 38% of patients reporting they are "sometimes" or "often" feeling anxious, depressed or irritable. On the post-visit survey, however, the great majority of patients said they did not feel anxious or

---

<sup>37</sup> Frederick, "Cognitive Reflection and Decision Making."

nervous during the visit (63% completely disagreed with feeling nervous, while another 6% mostly disagreed; only 9% agreed to feeling nervous).

Patients who were randomized to complete the PROMs first had a numerically higher rate of reporting that they remembered to ask the physician the questions they had (94.7% vs. 86.7%,  $p=0.1$ ; Table 2), and felt less nervous during the visit (15.8% vs. 46.7%,  $p=0.07$ ). Of note, there was a lower rate of PROMs completion in patients who completed the CRT first, which was likely due to the design of the study (less time allotted for the PROMs after the CRT, possible that the patients were interrupted prior to finished PROMs). But this does not affect the primary analysis of CRT scores (which compares patients who completed the first CRT vs. PROMs first).

#### **IV. Discussion**

In this pilot study of frame of mind of patients immediately before a medical appointment, the majority of patients had a score of 0 on the CRT, which has been associated with an automatic, System 1 frame of mind.

The distribution of the scores in our study was right-skewed, suggesting the mean is an overestimate of the true population distribution (i.e. median). The patients were young and well educated, and comparable in demographics to those previous populations. To our knowledge, the CRT or comparable testing has not been done in similar populations of patients. In addition, the majority of wrong answers were the intuitive answers that we would expect, suggesting that patients



fell in the “intuitive” trap and did not only get low scores because of mathematical mistakes.

Especially in light of the preliminary nature of our results, possible reasons for those results will be discussed, as well as implications for future research and policy.

### **A. Role of Anxiety**

Despite prior published literature on high rates of situational anxiety in patients<sup>38</sup>, in our cohort patients self-reported a low level of anxiety or nervousness prior to the visit. Anxiety has been shown to affect understanding of the medical encounter and downstream decisions. For instance, in a study where women were randomized to receive mammogram results from either a physician with a calm expression or one with a worried expression, the group randomized to the worried physician showed significantly lower recall, concern for worse prognosis, and more anxiety<sup>39</sup>. In addition, anxiety has been shown to increase heart rate and blood pressure during appointments, which can lead to dramatic changes in management<sup>40</sup>. Techniques to reduce anxiety have been shown to improve satisfaction<sup>41</sup>. We did not observe a correlation between higher anxiety levels and

---

<sup>38</sup> J. Lawton et al., "Improving Communication and Recall of Information in Paediatric Diabetes Consultations: A Qualitative Study of Parents' Experiences and Views," *BMC Pediatr* 15 (2015).

<sup>39</sup> D. E. Shapiro et al., "The Effect of Varied Physician Affect on Recall, Anxiety, and Perceptions in Women at Risk for Breast Cancer: An Analogue Study," *Health Psychol* 11, no. 1 (1992)..

<sup>40</sup> Stanley S. Franklin et al., "White-Coat Hypertension: New Insights from Recent Studies," *Hypertension* 62, no. 6 (2013)., K. Lovibond et al., "Cost-Effectiveness of Options for the Diagnosis of High Blood Pressure in Primary Care: A Modelling Study," *Lancet* 378, no. 9798 (2011).

<sup>41</sup> Rosalyn Cama, *Evidence-Based Healthcare Design*, A Wiley Book on Evidence-Based Design (Hoboken, N.J.: John Wiley & Sons, 2009)., F. Becker, B. Sweeney, and K. Parsons,

lower CRT scores; this pilot study however was not powered to confidently rule out that correlation. In addition, the majority of patients in our study had a score of 0, irrespective of their levels of self-reported anxiety, which suggests another, possibly stronger, factor is at play.

Interestingly, we observed a trend towards *higher* CRT scores in the patients who reported feeling generally depressed or anxious in the previous two weeks on the PROMs questionnaires; indeed, sadness is an emotion that usually triggers System 2 thought<sup>42</sup>. While we will also explore other hypotheses to explain our findings in the next sections, it does seem important to further investigate the role of nervousness or anxiety on frame of mind prior to a visit, as previous literature and personal experience do suggest the majority of patients are in fact anxious. In a larger patient sample, an assessment of current mood should be more detailed<sup>43</sup> and performed prior to the visit (to avoid recall bias that is possible when the self-reported mood surveys were completed after the visit).

## **B. Bandwidth Tax**

An alternative hypothesis is that patients are in a System 1 frame of mind on pre-visit tasks due because of they are facing a “bandwidth tax” from being focused on the medical visit. If that hypothesis were correct, we would expect to see patients

---

"Ambulatory Facility Design and Patients' Perceptions of Healthcare Quality," *HERD* 1, no. 4 (2008).

<sup>42</sup> Kahneman, *Thinking, Fast and Slow*.

<sup>43</sup> The short-form of the State Trait Anxiety Inventory, for instance, has been used to assess situational anxiety in a medical environment: A. Tluczek, J. B. Henriques, and R. L. Brown, "Support for the Reliability and Validity of a Six-Item State Anxiety Scale Derived from the State-Trait Anxiety Inventory," *J Nurs Meas* 17, no. 1 (2009).

perform better on tasks related to their medical appointment. While we did not test this specifically in this study, it has been previously shown that the majority of patients have poor recall for their medical history during appointments, as well as for information given during the appointment<sup>44,45</sup>, which argues against the System 1 frame of mind being only a temporary state during a non-medical task. This hypothesis could be tested further by using a cognitive reflection test that is more closely related to medical examples.

### **C. The Scarcity Hypothesis and “Tunneling”**

A related but more general framework that could explain the poor performance on the CRT is the problem of cognitive scarcity, as described by Mullainathan and Shafir<sup>46</sup>. If patients suffer from such scarcity, they would be expected to suffer from “tunneling,” and thus be unable to perform well on tasks that are outside of the area on which they are focused. For instance, the majority of patients have infrequent appointments, which are difficult to schedule and usually shorter than the patient would like. There is a scarcity of time to talk to the physician - although unfortunately usually an abundance of time in the uncomfortable waiting room. Patients would thus feel a scarcity of time, and tunnel on the upcoming appointment; any distraction that takes time, such as completing questionnaires or forms, is not a task on which they are willing to spend much

---

<sup>44</sup> Parkin and Skinner, "Discrepancies between Patient and Professionals Recall and Perception of an Outpatient Consultation."

<sup>45</sup> Houts et al., "Using Pictographs to Enhance Recall of Spoken Medical Instructions."

<sup>46</sup> Mullainathan and Shafir, *Scarcity: Why Having Too Little Means So Much*.

cognitive energy. We did observe in our study that patients completed the CRT quickly; they were not directly observed in order to avoid pressure from the study staff (a physician), but the PROMs surveys were time stamped which allowed us to approximate that most patients completed the CRT in less than 3 minutes.

An important partner to the tunneling problem seen in subjects who feel scarcity is the “focus dividend”: subjects tend to perform better at tasks directly related to their area of scarcity. But patients in this study (and the general population) are not more time-efficient during the visit itself, nor are they more focused. This hypothesis could be tested further by randomizing some patients to a time-limited cognitive reflection tool; we would expect the subjects who are now focused on the time scarcity to have a better performance than the ones who are not.

Other sources of scarcity- such as difficulty of access to a physician, or prediction of the cost of the visit and associated tests, or implications for ability to work- would be expected to also play a role. Our patient population was homogeneous with regards to those variables, as most had either private or state-sponsored comprehensive health insurance, and easy access (in person, by virtual visits or telephone) to the physicians in question.

#### **D. Future Directions**

In addition to exploring the factors that drive patients towards a System 1 framework, future studies should investigate methods to encourage a System 2 frame of mind. We hypothesize that patients in System 2 will have better objective recall of information given to them by their physician, and a more accurate

understanding on the medical information they were given. While the gold standard for this study would be a clinical trial including recordings of the patient visits and post-visit interviews, a proof-of-concept study could be done with healthy volunteers and mock medical scenarios. Survey participants who have experienced at least one physician visit in the last 5 years (a large study base) would be asked to recall that visit (and focused on it by being given a hypothetical medical scenario, and asked to compare it to their own experience). They would then be given a task to assess whether they are in System 1 or System 2; participants would be randomized to four conditions, depending on the medical relevance of the task<sup>47</sup> and whether a time limit for the task is salient. To the extent that patients are not in a position to make good decisions in a doctor's office, it makes evident sense to defer final judgments until some time when they are more likely to be able to reflect and deliberate.

While we have focused on the adverse consequences of System 1, it must be added that there are important advantages. For example, patients may be in a good position to pick up on important intuitive cues (from the cleanliness and arrangement of the waiting room, to the mood of the physician). In addition, the frame of mind of physicians has not been studied, and it is possible that a concordance between frame of mind of the physician and patient might make for a better interaction than the benefits derived from a patient being in a System 2 frame of mind.

---

<sup>47</sup> For example, an adaptation of Raven's Progressive Matrices with medically-salient symbols

Finally, the implications for improved design of the pre-visit experience are rich, from an individual provider to a national policy level. As the cost of healthcare continues to increase exponentially while the overall health of Americans does not, there is increased interest in improving patient involvement in their care and adherence to therapy<sup>48</sup>. Understanding the frame of mind of patients is crucial in designing these interventions.

The power of nudges, for instance, which are starting to be successfully used in the public health arena, should be harnessed by physicians to the advantage of patients- as opposed to their disadvantage, in the current state, by using medical jargon and statistics that they are likely to misinterpret by System 1. PROMs are a promising vehicle that can both measure effect of care when performed longitudinally, but also set anchors and influence frame of mind if designed for that purpose. As pre-visit questionnaires are becoming more common, we should focus on their effects and intelligent design to nudge patients towards healthier behaviors<sup>49</sup> and prime them for a better encounter with their physician.

## V. Conclusion

---

<sup>48</sup> Financial incentives are starting to be aligned, with the movement to value-based instead of volume-based reimbursements.

<sup>49</sup> As opposed to the current forms that print a list of medications and ask patients to verify it, a “nudging” form might ask them to visualize the time of the day they take their medications and write them down themselves. It might emphasize the feeling of personal responsibility and might increase adherence, as was suggested in the study in which a significant increase in the rate of immunization was seen in the Yale students that were primed by asking them to draw the route they would take from their residential college to the health center (Thaler and Sunstein, *Nudge : Improving Decisions About Health, Wealth, and Happiness*.)

In a pilot study, we have found that the great majority of patients perform very poorly on the cognitive reflection test prior to a physician appointment. Completion of PROMs surveys did not produce a significant improvement. The finding that patients are in an intuitive state of mind, reliant on heuristics and vulnerable to biases, offers an new framework in which to devise interventions to improve patient participation in their medical visits, recall of information, and decision-making. We suspect that patients are highly vulnerable to poor decision-making and that helpful interventions will either weaken the hold of intuitive thinking within the office or postpone important decisions until a time when patients are in a more reflective state of mind.

**Table 1: Demographics**

<b>Characteristic</b>	<b>Overall</b>	<b>CRT group</b>	<b>PROMs group</b>	<b>p-value</b>
Age (mean, SD)	47.7 (20.0)	49.7 (20.2)	45.6 (20.0)	0.5
Female gender (%)	49%	38%	61%	0.2
Highest education level (%)				0.8
High school diploma	6%	0%	11%	
Some college	30%	27%	33%	
Associate/Bachelor's	42%	53%	33%	
Master's degree	15%	13%	17%	
Professional or doctorate degree	6%	7%	6%	
English as first language (%)	93%	93%	92%	0.5

**Table 2: PROMS and self-reported states**

<b>Characteristic</b>	<b>Overall</b>	<b>CRT group</b>	<b>PROMs group</b>	<b>p-value</b>
<b>% answering "somewhat" or "completely agree"</b>				
I remembered to ask the questions I wanted to	91.2%	86.7%	94.7%	NS
I remember the information/instructions from the physician	94.1%	93.3%	94.7%	NS
I feel confident that I understood what I discussed with my doctor today	94.1%	93.3%	94.7%	NS
I was feeling nervous or anxious during the visit	29.2%	46.7%	15.8%	0.07

\*p-value calculated from Fisher's exact test for all categories



**Figure 1: Frederick's Cognitive Reflection Test<sup>50</sup>**

- (1) A bat and a ball cost \$1.10 in total. The bat costs \$1.00 more than the ball.  
How much does the ball cost?    cents
- (2) If it takes 5 machines 5 minutes to make 5 widgets, how long would it take  
100 machines to make 100 widgets?    Minutes
- (3) In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it  
takes 48 days for the patch to cover the entire lake, how long would it take  
for the patch to cover half of the lake?    day

*Intuitive (incorrect) answers: 10/100/24*

*Correct answers: 5/5/47*

---

<sup>50</sup> Frederick, "Cognitive Reflection and Decision Making."

## Figure 2: Kansas City Cardiomyopathy Questionnaire- short form

### Kansas City Cardiomyopathy Questionnaire (KCCQ-12)

The following questions refer to your heart failure and how it may affect your life. Please read and complete the following questions. There are no right or wrong answers. Please mark the answer that best applies to you.

1. Heart failure affects different people in different ways. Some feel shortness of breath while others feel fatigue. Please indicate how much you are limited by heart failure (shortness of breath or fatigue) in your ability to do the following activities over the past 2 weeks.

Activity	Extremely Limited	Quite a bit Limited	Moderately Limited	Slightly Limited	Not at all Limited	Limited for other reasons or did not do the activity
a. Showering/bathing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. Walking 1 block on level ground	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. Hurrying or jogging (as if to catch a bus)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	1	2	3	4	5	6

2. Over the past 2 weeks, how many times did you have swelling in your feet, ankles or legs when you woke up in the morning?

Every morning	3 or more times per week but not every day	1-2 times per week	Less than once a week	Never over the past 2 weeks
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5

3. Over the past 2 weeks, on average, how many times has fatigue limited your ability to do what you wanted?

All of the time	Several times per day	At least once a day	3 or more times per week but not every day	1-2 times per week	Less than once a week	Never over the past 2 weeks
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7

4. Over the past 2 weeks, on average, how many times has shortness of breath limited your ability to do what you wanted?

All of the time	Several times per day	At least once a day	3 or more times per week but not every day	1-2 times per week	Less than once a week	Never over the past 2 weeks
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5	6	7

5. Over the past 2 weeks, on average, how many times have you been forced to sleep sitting up in a chair or with at least 3 pillows to prop you up because of shortness of breath?

Every night	3 or more times per week but not every day	1-2 times per week	Less than once a week	Never over the past 2 weeks
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5

KCCQ-12  
Page 2 of 2

6. Over the past 2 weeks, how much has your heart failure limited your enjoyment of life?

It has extremely limited my enjoyment of life	It has limited my enjoyment of life quite a bit	It has moderately limited my enjoyment of life	It has slightly limited my enjoyment of life	It has not limited my enjoyment of life at all
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5

7. If you had to spend the rest of your life with your heart failure the way it is right now, how would you feel about this?

Not at all satisfied	Mostly dissatisfied	Somewhat satisfied	Mostly satisfied	Completely satisfied
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1	2	3	4	5

8. How much does your heart failure affect your lifestyle? Please indicate how your heart failure may have limited your participation in the following activities over the past 2 weeks.

Activity	Severely Limited	Limited quite a bit	Moderately limited	Slightly limited	Did not limit at all	Does not apply or did not do for other reasons
a. Hobbies, recreational activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. Working or doing household chores	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. Visiting family or friends out of your home	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	1	2	3	4	5	6

**Figure 3: PROMIS-10<sup>51</sup>**

Item	Scale
<p>In general, would you say your health is:</p> <p>In general, would you say your quality of life is:</p> <p>In general, how would you rate your physical health?</p> <p>In general, how would you rate your mental health, including your mood and your ability to think?</p> <p>In general, how would you rate your satisfaction with your social activities and relationships?</p> <p>In general, please rate how well you carry out your usual social activities and roles. (This includes activities at home, at work and in your community, and responsibilities as a parent, child, spouse, employee, friend, etc.)</p>	<p>Excellent</p> <p>Very Good</p> <p>Good</p> <p>Fair</p> <p>Poor</p>
<p>To what extent are you able to carry out your everyday physical activities such as walking, climbing stairs, carrying groceries, or moving a chair?</p>	<p>Completely</p> <p>Mostly</p> <p>Moderately</p> <p>A little</p> <p>Not at all</p>
<p>In the past 7 days, how often have you been bothered by emotional problems such as feeling anxious, depressed or irritable?</p>	<p>Never</p> <p>Rarely</p> <p>Sometimes</p> <p>Often</p> <p>Always</p>
<p>In the past 7 days, how would you rate your fatigue on average?</p>	<p>None</p> <p>Mild</p> <p>Moderate</p> <p>Severe</p> <p>Very Severe</p>
<p>In the past 7 days, how would you rate your pain on average?</p>	<p>No Pain (0) to Worst Pain Imaginable Pain(10)</p>

<sup>51</sup> J. E. Broderick et al., "Advances in Patient-Reported Outcomes: The Nih Promis((R)) Measures," *EGEMS (Wash DC)* 1, no. 1 (2013).

**Figure 4: Patient Health Questionnaire-2**

Over the last 2 weeks, how often have you been bothered by little interest or pleasure in doing things?

Over the last 2 weeks, how often have you been bothered by Feeling down, depressed, or hopeless?

Not at all; several days; more than half the days; nearly every day

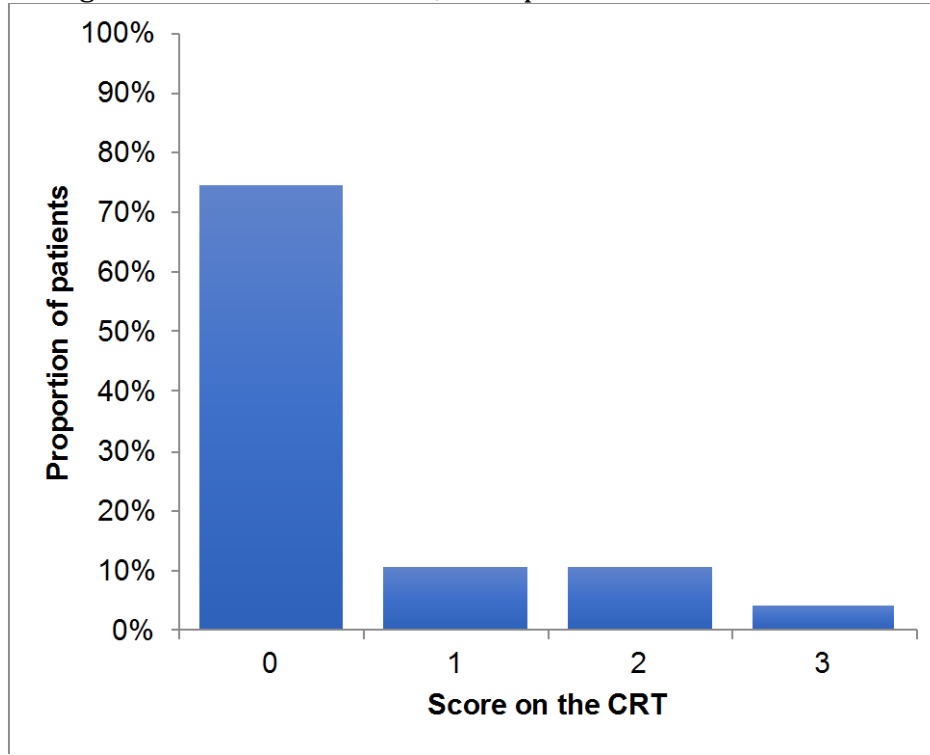
**Figure 5: Post-visit survey**

During your visit today, do you feel that:

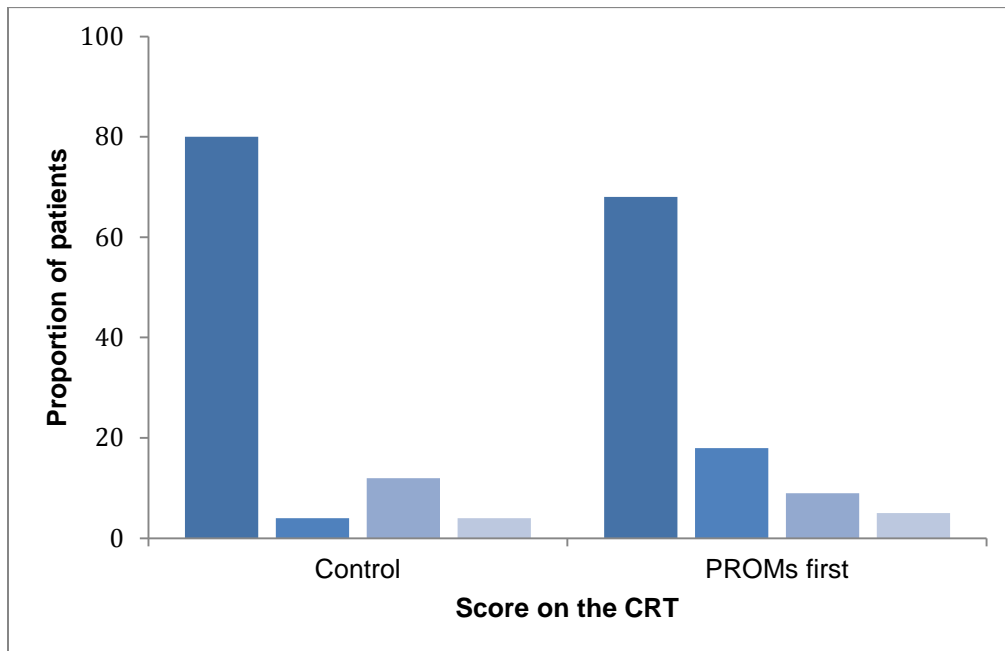
	Completely disagree	Somewhat disagree	Somewhat agree	Completely agree
I remembered to ask all the questions I meant to ask my doctor today				
I remember most of what the doctor told me to do today				
I feel confident that I understood what I discussed with my doctor today				
I was feeling nervous or anxious during the visit				

**Figure 6: CRT results**

A. Histogram of scores on the CRT, in all patients



B. Histogram of scores on the CRT by randomized study condition: patients who received PROMs first are the right, those who received the CRT first are on the left



## References

- Becker, F., B. Sweeney, and K. Parsons. "Ambulatory Facility Design and Patients' Perceptions of Healthcare Quality." *HERD* 1, no. 4 (Summer 2008): 35-54.
- Berg, N., G. Biele, and G. Gigerenzer. "Does Consistency Predict Accuracy of Beliefs? Economists Surveyed About Psa." (2010).
- Broderick, J. E., E. M. DeWitt, N. Rothrock, P. K. Crane, and C. B. Forrest. "Advances in Patient-Reported Outcomes: The Nih Promis((R)) Measures." *EGEMS (Wash DC)* 1, no. 1 (2013): 1015.
- Cama, Rosalyn. *Evidence-Based Healthcare Design*. A Wiley Book on Evidence-Based Design. Hoboken, N.J.: John Wiley & Sons, 2009.
- Campitelli, Guillermo, and Martin Labollita. "Correlations of Cognitive Reflection with Judgments and Choices." *Judgment and Decision Making* 5, no. 3 (2010): 182-92.
- Cella, D., S. Yount, N. Rothrock, R. Gershon, K. Cook, B. Reeve, D. Ader, *et al.* "The Patient-Reported Outcomes Measurement Information System (Promis): Progress of an Nih Roadmap Cooperative Group During Its First Two Years." *Med Care* 45, no. 5 Suppl 1 (May 2007): S3-S11.
- Franklin, Stanley S., Lutgarde Thijs, Tine W. Hansen, Eoin O'Brien, and Jan A. Staessen. "White-Coat Hypertension: New Insights from Recent Studies." *Hypertension* 62, no. 6 (December 1, 2013 2013): 982-87.
- Frederick, Shane. "Cognitive Reflection and Decision Making." *Journal of Economic Perspectives* 19, no. 4 (2005): 25-42.
- Gigerenzer, G., and A. Edwards. "Simple Tools for Understanding Risks: From Innumeracy to Insight." *BMJ* 327, no. 7417 (Sep 27 2003): 741-4.
- Halpern, S. D., G. Loewenstein, K. G. Volpp, E. Cooney, K. Vranas, C. M. Quill, M. S. McKenzie, *et al.* "Default Options in Advance Directives Influence How Patients Set Goals for End-of-Life Care." *Health Aff (Millwood)* 32, no. 2 (Feb 2013): 408-17.
- Hess, E. P., M. A. Knoedler, N. D. Shah, J. A. Kline, M. Breslin, M. E. Branda, L. J. Pencille, *et al.* "The Chest Pain Choice Decision Aid: A Randomized Trial." *Circ Cardiovasc Qual Outcomes* 5, no. 3 (May 2012): 251-9.
- Hess, Lisa M., Michael W. Method, Frederick B. Stehman, Tess D. Weathers, Paridha Gupta, and Jeanne M. Schilder. "Patient Recall of Health Care Events and Time to Diagnose a Suspected Ovarian Cancer." *Clinical Ovarian & Other Gynecologic Cancer* 5, no. 1: 17-23.
- Houts, P. S., R. Bachrach, J. T. Witmer, C. A. Tringali, J. A. Bucher, and R. A. Localio. "Using Pictographs to Enhance Recall of Spoken Medical Instructions." *Patient Educ Couns* 35, no. 2 (Oct 1998): 83-8.
- Kahneman, Daniel. *Thinking, Fast and Slow*. 1st pbk. ed. New York: Farrar, Straus and Giroux, 2013.
- Kahneman, Daniel, and Amos Tversky. "Prospect Theory: An Analysis of Decision under Risk." *Econometrica* 47, no. 2 (1979): 263-91.
- Kinnersley, P., K. Phillips, K. Savage, M. J. Kelly, E. Farrell, B. Morgan, R. Whistance, *et al.* "Interventions to Promote Informed Consent for Patients Undergoing

- Surgical and Other Invasive Healthcare Procedures." *Cochrane Database Syst Rev* 7 (2013): CD009445.
- Kohn, Linda T., Janet Corrigan, and Molla S. Donaldson. *To Err Is Human : Building a Safer Health System*. Washington, D.C.: National Academy Press, 2000.
- Kressel, L. M., and G. B. Chapman. "The Default Effect in End-of-Life Medical Treatment Preferences." *Med Decis Making* 27, no. 3 (May-Jun 2007): 299-310.
- Kressel, L. M., G. B. Chapman, and E. Leventhal. "The Influence of Default Options on the Expression of End-of-Life Treatment Preferences in Advance Directives." *J Gen Intern Med* 22, no. 7 (Jul 2007): 1007-10.
- Kroenke, K., R. L. Spitzer, and J. B. Williams. "The Patient Health Questionnaire-2: Validity of a Two-Item Depression Screener." *Med Care* 41, no. 11 (Nov 2003): 1284-92.
- Langewitz, Wolf, Selina Ackermann, Anette Heierle, Ralph Hertwig, Leyla Ghanim, and Roland Bingisser. "Improving Patient Recall of Information: Harnessing the Power of Structure." *Patient Education and Counseling* 98, no. 6 (6// 2015): 716-21.
- Lawton, J., N. Waugh, K. Noyes, K. Barnard, J. Harden, L. Bath, J. Stephen, and D. Rankin. "Improving Communication and Recall of Information in Paediatric Diabetes Consultations: A Qualitative Study of Parents' Experiences and Views." *BMC Pediatr* 15 (2015): 67.
- Levy, D. E., J. Riis, L. M. Sonnenberg, S. J. Barraclough, and A. N. Thorndike. "Food Choices of Minority and Low-Income Employees: A Cafeteria Intervention." *Am J Prev Med* 43, no. 3 (Sep 2012): 240-8.
- Lovibond, K., S. Jowett, P. Barton, M. Caulfield, C. Heneghan, F. D. Hobbs, J. Hodgkinson, *et al.* "Cost-Effectiveness of Options for the Diagnosis of High Blood Pressure in Primary Care: A Modelling Study." *Lancet* 378, no. 9798 (Oct 1 2011): 1219-30.
- Marewski, J. N., and G. Gigerenzer. "Heuristic Decision Making in Medicine." *Dialogues Clin Neurosci* 14, no. 1 (Mar 2012): 77-89.
- Mata, R., L. J. Schooler, and J. Rieskamp. "The Aging Decision Maker: Cognitive Aging and the Adaptive Selection of Decision Strategies." *Psychol Aging* 22, no. 4 (Dec 2007): 796-810.
- Merrick, E. L., D. Hodgkin, C. M. Horgan, L. S. Lorenz, L. Panas, G. A. Ritter, P. Kasuba, D. Poskanzer, and R. A. Nefussy. "Testing Novel Patient Financial Incentives to Increase Breast Cancer Screening." *Am J Manag Care* 21, no. 11 (Nov 2015): 771-9.
- Mullainathan, Sendhil, and Eldar Shafir. *Scarcity : Why Having Too Little Means So Much*. First edition. ed. New York: Times Books, Henry Holt and Company, 2013.
- Nelson, E. C., E. Eftimovska, C. Lind, A. Hager, J. H. Wasson, and S. Lindblad. "Patient Reported Outcome Measures in Practice." *BMJ* 350 (2015): g7818.
- Pachur, T., R. Mata, and L. J. Schooler. "Cognitive Aging and the Adaptive Use of Recognition in Decision Making." *Psychol Aging* 24, no. 4 (Dec 2009): 901-15.

- Parkin, T., and T. C. Skinner. "Discrepancies between Patient and Professionals Recall and Perception of an Outpatient Consultation." *Diabet Med* 20, no. 11 (Nov 2003): 909-14.
- Patel, M. S., D. A. Asch, A. B. Troxel, M. Fletcher, R. Osman-Koss, J. Brady, L. Wesby, *et al.* "Premium-Based Financial Incentives Did Not Promote Workplace Weight Loss in a 2013-15 Study." *Health Aff (Millwood)* 35, no. 1 (Jan 1 2016): 71-9.
- Patel, M. S., David A. Asch, Roy Rosin, Dylan S. Small, Scarlett L. Bellamy, Jack Heuer, Susan Sproat, *et al.* "Framing Financial Incentives to Increase Physical Activity among Overweight and Obese Adults: A Randomized, Controlled Trial." *Annals of Internal Medicine* (2016).
- Renjilian, C. B., J. W. Womer, K. W. Carroll, T. I. Kang, and C. Feudtner. "Parental Explicit Heuristics in Decision-Making for Children with Life-Threatening Illnesses." *Pediatrics* 131, no. 2 (Feb 2013): e566-72.
- Rothrock, N. E., R. D. Hays, K. Spritzer, S. E. Yount, W. Riley, and D. Cella. "Relative to the General Us Population, Chronic Diseases Are Associated with Poorer Health-Related Quality of Life as Measured by the Patient-Reported Outcomes Measurement Information System (Promis)." *J Clin Epidemiol* 63, no. 11 (Nov 2010): 1195-204.
- Sarfati, D., P. Howden-Chapman, A. Woodward, and C. Salmond. "Does the Frame Affect the Picture? A Study into How Attitudes to Screening for Cancer Are Affected by the Way Benefits Are Expressed." *J Med Screen* 5, no. 3 (1998): 137-40.
- Shapiro, D. E., S. R. Boggs, B. G. Melamed, and J. Graham-Pole. "The Effect of Varied Physician Affect on Recall, Anxiety, and Perceptions in Women at Risk for Breast Cancer: An Analogue Study." *Health Psychol* 11, no. 1 (1992): 61-6.
- Sonnenberg, L., E. Gelsomin, D. E. Levy, J. Riis, S. Barraclough, and A. N. Thorndike. "A Traffic Light Food Labeling Intervention Increases Consumer Awareness of Health and Healthy Choices at the Point-of-Purchase." *Prev Med* 57, no. 4 (Oct 2013): 253-7.
- Spertus, J. A., C. Decker, E. Gialde, P. G. Jones, E. J. McNulty, R. Bach, and A. K. Chhatriwalla. "Precision Medicine to Improve Use of Bleeding Avoidance Strategies and Reduce Bleeding in Patients Undergoing Percutaneous Coronary Intervention: Prospective Cohort Study before and after Implementation of Personalized Bleeding Risks." *BMJ* 350 (2015): h1302.
- Spertus, J. A., and P. G. Jones. "Development and Validation of a Short Version of the Kansas City Cardiomyopathy Questionnaire." *Circ Cardiovasc Qual Outcomes* 8, no. 5 (Sep 2015): 469-76.
- Stacey, D., F. Legare, N. F. Col, C. L. Bennett, M. J. Barry, K. B. Eden, M. Holmes-Rovner, *et al.* "Decision Aids for People Facing Health Treatment or Screening Decisions." *Cochrane Database Syst Rev* 1 (2014): CD001431.
- Stanovich, K. E., and R. F. West. "Individual Differences in Reasoning: Implications for the Rationality Debate?" *Behav Brain Sci* 23, no. 5 (Oct 2000): 645-65; discussion 65-726.
- Sunstein, Cass R. "Deciding by Default." *University of Pennsylvania Law Review* (2013).



- Thaler, Richard H., and Cass R. Sunstein. *Nudge : Improving Decisions About Health, Wealth, and Happiness*. Rev. and expanded ed. New York: Penguin Books, 2009.
- Thorndike, A. N., J. Riis, and D. E. Levy. "Social Norms and Financial Incentives to Promote Employees' Healthy Food Choices: A Randomized Controlled Trial." *Prev Med* 86 (Jan 29 2016): 12-18.
- Thorndike, A. N., J. Riis, L. M. Sonnenberg, and D. E. Levy. "Traffic-Light Labels and Choice Architecture: Promoting Healthy Food Choices." *Am J Prev Med* 46, no. 2 (Feb 2014): 143-9.
- Thuczek, A., J. B. Henriques, and R. L. Brown. "Support for the Reliability and Validity of a Six-Item State Anxiety Scale Derived from the State-Trait Anxiety Inventory." *J Nurs Meas* 17, no. 1 (2009): 19-28.
- Tversky, A., and D. Kahneman. "The Framing of Decisions and the Psychology of Choice." *Science* 211, no. 4481 (Jan 30 1981): 453-8.
- Tversky, A., and D. Kahneman. "Judgment under Uncertainty: Heuristics and Biases." *Science* 185, no. 4157 (Sep 27 1974): 1124-31.
- Ubel, P. A., D. A. Comerford, and E. Johnson. "Healthcare.Gov 3.0--Behavioral Economics and Insurance Exchanges." *N Engl J Med* 372, no. 8 (Feb 19 2015): 695-8.
- Waljee, J. F., M. A. Rogers, and A. K. Alderman. "Decision Aids and Breast Cancer: Do They Influence Choice for Surgery and Knowledge of Treatment Options?". *J Clin Oncol* 25, no. 9 (Mar 20 2007): 1067-73.
- Wasson, J. H., T. A. Stukel, J. E. Weiss, R. D. Hays, A. M. Jette, and E. C. Nelson. "A Randomized Trial of the Use of Patient Self-Assessment Data to Improve Community Practices." *Eff Clin Pract* 2, no. 1 (Jan-Feb 1999): 1-10.
- Weeks, J. C., E. Cook, S. J. O'Day, and et al. "Relationship between Cancer Patients' Predictions of Prognosis and Their Treatment Preferences." *JAMA* 279, no. 21 (1998): 1709-14.