

# Boundedly rational patients? Part 2: Health and patient mistakes in a behavioral framework

Ada C. Stefanescu Schmidt<sup>1</sup>, Ami B. Bhatt<sup>2</sup>, Cass R. Sunstein<sup>3\*</sup>

## Abstract

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.

**JEL Classification:** C91; D83; I12

## Keywords

Cognitive Reflections Test — patient-reported outcomes measurement information system — System 1 and System 2 — nudges

<sup>1</sup> Division of Cardiology, Massachusetts General Hospital and Harvard Medical School

<sup>2</sup> Outpatient Cardiology, Massachusetts General Hospital, Professor at Harvard Medical School

<sup>3</sup> Robert Walmsley University, Professor at Harvard University

\*Corresponding author: csunstei@me.com

In an earlier essay in this journal, we speculated 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 result, we suggested that patients are likely to make serious errors, and that this behaviorally informed point is likely to have implications for medical care and health policy. In this essay, we report a pilot study, meant to test our speculation.

## Methods

We performed a randomized assignment study of patients from the Massachusetts General Hospital Adult Congenital Heart Disease clinic. Patients over the age of 18, 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 patient-reported outcomes measure (PROM) first.

The CRT is a three-question tool designed by Frederick to assess frame of mind (Figure 1; Frederick, 2005). The questions are simple mathematical problems that have an intuitive but incorrect answer. Importantly, subjects with low scores on the test 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. Scores on the CRT are correlated with, but not completely explained by intelligence or cognitive ability (Frederick, 2005; Toplak, West, Stanovich, 2014). While serial administration of the CRT to evaluate changes in frame of mind over time in one subject has not, to our knowledge, been studied (in part limited by the high likelihood subjects will remember the questions and their previous answers), the slight improvement in average scores on the third compared to those of the first question on the CRT suggests that the CRT does provide a measure of a fluid frame of mind (Frederick, 2005). In addition, prompts that activate System 2 (such as disfluency provoked by difficult-to-read fonts) have been shown to be associated with higher CRT scores (Alter, Oppenheimer, Epley, Eyre, 2007).

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 (KCCQ, see Spertus Jones, 2015; Figure 2), Patient-Reported Outcomes Measurement Information System<sup>1</sup> (PROMIS-10; Figure 3) and Patient Health Questionnaire-2 (PHQ2, see Kroenke, Spitzer, Williams, 2003; Figure 4) questionnaires.

<sup>1</sup> Cella et al., 2007 and Rothrock et al., 2010.

Table 1. Demographics

Characteristic	Overall	CRT group	PROMs group	p-value
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 educational level (%)				
High school diploma	6%	0%	11%	0.8
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

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 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.

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.

Student's t-test 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>2</sup>.

## Results

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.

The primary endpoint of 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 (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 (Frederick, 2005).

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  $r=-0.16$ ,  $p=0.37$ ). 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,  $p=0.17$ ).

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

<sup>2</sup> From Frederick, 2005 and Campitelli Labollita, 2010.

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

Characteristic % answering “somewhat” or “completely agree”	Overall	CRT group	PROMs group	p-value
I remember 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.

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 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).

## 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 patients in a healthcare setting. 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.

### Role of Anxiety

Despite prior published literature on high rates of situational anxiety in patients (Lawton et al., 2015), 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 (Shapiro, Boggs, Melamed, Graham-Pole, 1992). In addition, techniques to reduce anxiety during a medical visit have been shown to improve patient satisfaction<sup>3</sup>. We did not observe a correlation between higher anxiety levels and 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 (Kahneman, 2013). 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>4</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).

### 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 perform better on tasks related to their medical appointment. While we did not test this specifically in this study, it has

<sup>3</sup> See Cama, 2009, Becker, Sweeney, Parsons, 2008.

<sup>4</sup> The short-form of the State Trait Anxiety Inventory, for instance, has been used to assess situational anxiety in a medical environment: (Tluczek, Henriques, Brown, 2009).

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 (see Parkin Skinner, 2003, Houts et al., 1998) 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.

### 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 (2013). 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 cognitive energy. We did observe in our study that patients completed the CRT quickly, with most patients proceeding to the next task in less than 3 minutes despite not being observed or allotted a limited amount of time for the study.

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.

### 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 and whether a time limit for the task<sup>5</sup> is salient.

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.

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>6</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. 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. 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>7</sup> and prime them for a better encounter with their physician.

<sup>5</sup> For example, an adaptation of Raven’s Progressive Matrices with medically-salient symbols.

<sup>6</sup> Financial incentives are starting to be aligned, with the movement to value-based instead of volume-based reimbursements.

<sup>7</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 Sunstein, 2009).

## Conclusion

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 prior to CRT did not produce a significant improvement in scores. The finding that patients are in an intuitive state of mind, reliant on heuristics and vulnerable to biases, offers a 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.

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Appendix

Figure 1. Frederick’s Cognitive Reflection Test<sup>8</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

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

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

<sup>8</sup> (Frederick, 2005).

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>9</sup>

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

<sup>9</sup> (Broderick, DeWitt, Rothrock, Crane, Forrest, 2013).

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

(1) Over the last 2 weeks, how often have you been bothered by little interest or pleasure in doing things?	Not at all Several days More than half the days
(2) Over the last 2 weeks, how often have you been bothered by Feeling down, depressed, or hopeless?	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.

