Numeracy and the Affordable Care Act:

Opportunities and challenges

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Abstract

Numbers are used to instruct, inform, and give meaning to information in order to help us make better judgments and healthier choices in our everyday lives. However, research has demonstrated that not all people can understand and use numbers effectively. In particular, people differ in numeracy. Among <u>uninsured adults</u>, we estimated that 28.8% are at a Below Basic level of numeracy, 33.4% are at a Basic level, 29.3% are at an Intermediate level, and only 8.6% are at a Proficient level of numeric literacy. Numeracy skills needed to select a health plan, choose treatments, and understand medication instructions include education-based skills and emergent decision-based abilities. We estimate that the skills needed to make many complex informed health decisions (e.g., management of chronic diseases) require a Proficient level of numeric literacy, given how numeric information is often provided. However, if health information providers present information to patients and consumers in an evidence-based manner, a greater proportion of the population will be successful in making informed health and health-related decisions. We identify five main communication themes and discuss evidence-based strategies for communication under each theme.

INTRODUCTION

Numbers are used to instruct, inform, and give meaning to information in order to help us make better judgments and healthier choices in our everyday lives. However, research has demonstrated that not all people can understand and use numbers effectively. In particular, people differ in numeracy. Numeracy has variously been defined as the ability to use basic probability and mathematical concepts (Peters et al., 2006) and as "'the degree to which individuals can obtain, process, and understand the basic [quantitative] health information and services they need to make appropriate health decisions' (Ratzan & Parker, 2000). Berkman et al. (2011) further describe the concept of health numeracy as representing "a constellation of skills necessary to function effectively in the health care environment and act appropriately on health care information." Even highly educated individuals can be innumerate (Lipkus, Samsa, & Rimer, 2001).

Previous reports have focused on what is known about the relation of numeracy to health outcomes and disparities (Berkman et al., 2011). With so many Americans lacking basic numeracy skills, it is important to know whether and how numeracy influences health outcomes and health disparities. Berkman et al. (2011) conducted a systematic review of numeracy. They concluded that the strength of current evidence was insufficient with respect to the relation of numeracy to health outcomes such as knowledge, risk perception accuracy, and accurate interpretation of health information. Numeracy, however, did appear to mediate some health disparities (e.g., between race and levels of hemoglobin A1c and between gender and HIV medication management capacity) although the strength of evidence was low. Conclusions could not be drawn about the relation of numeracy to use of health-care services. Numeracy does appear to be more highly correlated with health outcomes than is health literacy although possible ceiling effects on health literacy could have clouded the health literacy effects.

In the present commissioned paper, our task was to consider the following statement of task: "With the implementation of health care reform, there will be an influx of previously uncovered individuals who have limited knowledge, understanding, and ability to navigate the health care choices available. Of particular importance will be numeracy skills needed to make informed choices about which health plan best meets individual needs, how to make informed treatment decisions (for example, X treatment has a 5% greater risk than Y), and understanding medication instructions. The roundtable will hold a meeting July 18, 2013 in Washington, D.C. to explore such issues."

This commissioned paper addresses three questions:
1. What research shows about people's numeracy skill levels,
2. What kinds of numeracy skills are needed to select a health plan, choose treatments, and understand medication instructions, and
3. How can providers communicate with those with low numeracy skills?

**QUESTION 1: WHAT DOES RESEARCH SHOW ABOUT
PEOPLE'S NUMERACY SKILL LEVELS?**

Numeracy can be assessed with objective measures (e.g., "If person A's chance of getting a disease is 1 in 100 in 10 years and person B's risk is double that of A, what is B's risk?"; Cokely et al., 2012; Lipkus et al., 2001; Weller et al., in press) and subjective measures (e.g., "How good are you at working with fractions?"; Fagerlin et al., 2007). There are also general

health numeracy measures, such as the Numeracy Understanding in Medicine Instrument (NUMi; Shapira et al., 2012) and various numeracy measures specific to health domains such as asthma, diabetes, and anticoagulation control (Apter et al., 2006; Estrada et al., 2004; Huizinga et al., 2008). Other studies have simply tallied how well individuals can do specific health-related numeric tasks. For example, in an online survey representative of the U.S. population, 79% of parents claimed to have seen a growth chart before, and most think that they understand them well (Ben-Joseph, Dowshen, & Izenberg, 2009). However, when provided with multiple-choice questions and answers, only 64% could identify a child's weight when shown a plotted point on a growth chart and up to 77% misinterpreted charts that included both height and weight measurements. Like other innumeracy-related health examples, this may be important because parents may use their (inaccurate) understanding to guide related health decisions for their children.

As suggested above, Americans have limited numeracy skills. A recent probabilistic sample of Americans answered fewer than two-thirds of simple statistical numeracy questions correctly (Galesic & Garcia-Retamero, 2010). Even for the easiest question ("If the chance of getting a disease is 10%, how many people would be expected to get the disease out of 1000?"), 17% answered incorrectly. For the most difficult item ("In the Daily Times Sweepstakes, the chance of winning a car is 1 in 1000. What percentage of tickets for the Daily Times Sweepstakes win a car?"), participants had to translate 1 in 1000 to a percentage; only 24% did so successfully. Wide disparities in numeracy also existed such that higher scores existed for men vs women, younger adults vs older adults, more educated adults vs less educated adults, and higher vs lower income adults (independent effects existed for only sex, education, and income).

The 2003 National Assessment of Adult Literacy (NAAL) defined numeracy (also called quantitative literacy) as "the ability to understand and use numbers in daily life" (Kutner et al., 2007). They estimated the proportion of Americans who fall into Below Basic, Basic, Intermediate, and Proficient quantitative literacy performance levels. The survey was administered to more than 19,000 adults (ages 16 and older) living in households or prisons. To be classified into each quantitative literacy level, one has to exhibit a set of specific quantitative skills and not exhibit the specific skills of the quantitative literacy level above it.

Key abilities that adults needed to demonstrate to be classified into each level can be found in Table 1. For example, key abilities at the Below Basic level include finding numbers and using them to perform simple operations (mostly addition) when the information is familiar and concrete. For example, adding two numbers to complete an ATM deposit slip is a task categorized at the Below Basic level of quantitative literacy. In contrast, a sample task from the Intermediate level involved determining what time a person can take a prescription medication, given instructions on taking the medication in relation to eating. A sample task at the highest performance level, Proficient, involved calculating the yearly cost of life insurance using a table that gives the cost per month for each $1,000 of coverage. Individuals with less than Proficient abilities (those at Below Basic, Basic, or Intermediate levels) are expected not to be able to perform this sample life-insurance task.

Results from the NAAL indicated that 22% of American adults are at the Below Basic level, 33% are at the Basic level, 33% are at the Intermediate level, and 13% of adults are at the Proficient level of quantitative literacy. Results also indicated demographic differences in quantitative abilities. Males scored higher than females, high-income individuals scored higher than low income, and the more educated scored higher than the less educated. In addition, scores among white and Asian/Pacific Islander adults were higher than scores for Black and Hispanic

adults. No analyses were available concerning whether any single demographic variable predicted quantitative literacy scores over and above other demographic variables.

The proportions of individuals at each quantitative literacy level are based on the overall U.S. population, however, and may not accurately reflect the numeracy abilities we should expect from previously uninsured adults who will now enter the health-care system as the result of the Patient Protection and Affordable Care Act (ACA). By combining the NAAL's data with the 2009-2011 Census Bureau data (United States Census Bureau, 2009-2011), we estimated the proportion of uninsured and insured American adults who fall into Below Basic, Basic, Intermediate, and Proficient quantitative literacy categories (see Table 1). For these estimates, we used the 2003 NAAL that provides data on the proportion of adults in each quantitative literacy level based on their educational attainment; the 2009-2011 Census Bureau provides data on the proportion of uninsured and insured adults at each level of educational attainment.

Using these two data sources, we estimated that, among uninsured adults, 28.8% are at the Below Basic level, 33.4% are at the Basic level, 29.3% are at the Intermediate level, and only 8.6% are at the Proficient level. Among insured adults, we estimated that 18.2% are at the Below Basic level, 31.9% are at the Basic level, 35.3% are at the Intermediate level, and 14.6% are at the Proficient level. See Appendix A for a more detailed explanation of how these estimates were calculated and the limitations of these estimates. Given these estimates, roughly 29% (9,170,000) of uninsured adults and 18% (30,600,000) of insured adults lack the Basic quantitative skills necessary to locate quantitative information and use it to solve simple one-step arithmetic problems. Approximately 62% (19,800,000) of uninsured adults and 50% (84,300,000) of insured American adults lack the Intermediate quantitative skills necessary to locate less familiar quantitative information and use it to solve problems in which the arithmetic operation is not specified.

Table 1. Key abilities and estimated proportion of adults at each level of quantitative literacy

Quantitative Literacy Level	% of adults in each level (NAAL findings)	Estimated % (#) of uninsured adults in each*	Estimated % (#) of insured adults in each*	Key abilities associated with level (NAAL)
Below Basic	22%	28.8% or 9,169,063	18.2% or 30,596,144	locating numbers and using them to perform simple quantitative operations (primarily addition) when the mathematical information is very concrete and familiar
Basic	33%	33.4% or 10,656,748	31.9% or 53,702,419	locating easily identifiable quantitative information and using it to solve simple, one-step problems when the arithmetic operation is specified or easily inferred
Intermediate	33%	29.3% or 9,339,640	35.3% or 59,508,631	locating less familiar quantitative information and using it to solve problems when the arithmetic operation is not specified or easily inferred
Proficient	13%	8.6% or 2,749,954	14.6% or 24,505,031	locating more abstract quantitative information and using it to solve multistep problems when the arithmetic operations are not easily inferred and the problems are more complex
Total U.S. Population 200,227,629	101%	100.1% or 31,915,404	100% or 168,312,225	

Note. Individuals at each level of quantitative literacy are thought to have the skills identified at that level, but are thought to not have the skills at levels above their own (e.g., an individual with Below Basic quantitative literacy should have the skills located in that row but would not have the skills located in the rows for Basic, Intermediate, or Proficient literacy).
* These estimates are not based on perfectly comparable samples. The sample from the NAAL consists of people 16 years of age and older living in households or prisons whereas the sample from the 2009-2011 Census is a civilian non-institutionalized population 25 years and over. Both samples also include older adults (65 years and older) who are not as relevant to ACA concerns because most are covered by Medicare. Although older adults tend to be less numerate, their inclusion likely affects the uninsured estimates very little (because most are insured), but mean that the insured population of younger individuals 18-64 years old likely have higher quantitative skills than what is reflected in Table 1.

Dual-Process Theories and the Potential Influence of Time Pressure, Stress, and Illness on Reductions To Health Numeracy Skills

Research in numeracy has been associated with what are known as "dual-process theories" in decision making (Peters, Vastfjall, et al., 2006). Information in decision making appears to be processed using an analytic mode of thinking, and an affective/experiential one (Epstein, 1994; Loewenstein et al., 2001; Reyna, 2004; Sloman, 1996; also called System 1 and 2, respectively, Stanovich & West, 2002; Kahneman, 2003). In particular, numeracy is considered an analytical skill – one has to think to do number calculations. Both modes of thought are important to forming decisions. The experiential mode is primarily based on affective (emotional) feelings, and processing using this mode is relatively effortless, automatic, and spontaneous. As shown in a number of studies, the affective feelings that are primary to this mode of thought provide both meaning and motivation to choice processes (Damasio, 1994). Processing in the analytic mode, on the other hand, is conscious, deliberative, reason-based, verbal, and relatively slow. The analytical mode of thinking is more flexible and provides effortful control over more spontaneous experiential processes. Both modes of thinking are important and good choices are most likely to emerge when affective and analytical modes work in concert and decision makers think as well as feel their way through judgments and decisions (Damasio, 1994). Research, however, has demonstrated that the experiential mode (and affect, in particular) has a relatively greater influence when analytical capacity is lower due to cognitive load or time pressure (Shiv & Fedorikhin, 1999; Finucane et al., 2000).

This distinction is important because being involved in health decisions often involves factors that reduce how well patients and consumers think (e.g., time pressure for a patient to make an informed choice in a physician's office, being sick, being stressed, or being overwhelmed with too much information). As a result, the numeric abilities of representative U.S. populations may overestimate the numeracy levels of patients making health decisions. This is because reported numeracy abilities for the U.S. population are usually measured in healthy individuals who are not under time pressure whereas patients seen by health-care providers may be subject to one of the factors above (e.g., being sick). These reduced numeracy abilities may lead to numeric sources of information being less well understood and used in health decisions while less relevant sources of affect and emotion play a larger role. Little health research, however, exists concerning this possibility.

QUESTION 2: WHAT KINDS OF NUMERACY SKILLS ARE NEEDED TO SELECT A HEALTH PLAN, CHOOSE TREATMENTS, AND UNDERSTAND MEDICATION INSTRUCTIONS?

Education-Based Numeracy Skills

Apter and colleagues (2008) presented a hierarchy of mathematical skills required to successfully complete numeric tasks while making health decisions. Higher level tasks include estimation, understanding probabilities, problem solving (the ability to decipher when and how to apply a numerical skill), understanding variability and error in measurement, and risk assessment. See the education-based numeracy skills of Table 2 adapted from Apter et al. (2008). Having the skills to successfully complete these tasks is expected to allow patients and consumers to locate numeric information and transform it in ways that allow them to make more

effective decisions about their health. Education-based skills are divided into four main skill categories including basic, computational, analytical, and statistical numeric skills. The basic skill to understand numeric information is necessary for many health-related tasks. When choosing a health plan from a health-insurance exchange, for example, consumers must be able to read and understand basic fees and use simple arithmetic operations, such as adding costs together. Such understanding is a fundamental building block to deciding which health plans they prefer and can afford. Similarly, taking medications correctly requires the ability to read and understand dosage and timing instructions. Computational skills to do tasks such as estimating sizes and understanding how to work with frequencies and percentages are particularly important when making treatment decisions because options can be described based on the likelihood of risks and benefits in frequentistic form (e.g., 10 out of 100 patients) or percentage form (e.g. 10% of patients).

For tasks requiring analytical skills, patients and consumers must have the ability to apply numeric information to solve problems, make inferences and interact with complex displays of information such as tables, graphs and maps. For example, understanding numeric information provided in formats such as frequencies and percentages may not, by itself, be sufficient for accurate risk perception. Peters et al. (2006) demonstrated that less numerate individuals were susceptible to format effects, presumably because the less numerate, although they likely understood the numbers in the sense that they could repeat them back accurately, did not transform numbers from one format to another. Specifically, in Peters, Hart, and Fraenkel (2011), experimenters presented participants with the likelihood of an adverse event from a prescribed medication either in a frequentistic format (10 of 100 patients get a bad blistering rash) or a probabilistic format (10% of 100 patients get a bad blistering rash). Both formats are normatively equivalent. The experimenters found that less numerate individuals perceived a greater risk of an adverse event when the likelihood estimate was described in a frequentistic format (10 of 100) than when it was described in a probabilistic format (10% of 100). In contrast, highly numerate individuals rated the level of risk the same in each information format. Normatively, the frame of information should not change the risk perception judgment.

In taking medications, other kinds of format issues appear. For example, with liquid medication, patients often use inaccurate measurement devices such as household spoons, and they often confuse teaspoons and tablespoons (Madlon-Kay & Mosch, 2000). In selecting health plans, consumers sometimes want to estimate annual costs. To do so correctly, they must transform some numbers (e.g., monthly premiums and biannual physician visits to annual) in order to add them to other numbers (e.g., annual deductibles). Such calculations require analytical skills and knowing how to apply numeric information to solve problems.

Finally, Apter includes concepts related to probabilistic reasoning in the Statistical skill category. This includes the understanding of variability and randomness, being able to evaluate relative versus absolute comparisons, and compare different risk assessments (cumulative, relative and conditional). Such skills are important because inclusion of preventive care services in plans offered in health exchanges means that the newly insured will need to choose between treatment options, and also choose whether or not to obtain preventive health screenings and treatments. To do so, consumers first must realize they are susceptible to a given disease (e.g., understand concepts of randomness and variability), and then understand the risks from the disease as well as the risk reduction from taking preventive steps (both relative and absolute risks). For example, imagine a patient who accurately understands that his risk of developing Type 2 diabetes is greater based on the percent chance (probability) of developing disease at his

current weight. He then can estimate how much his risk will be reduced with effortful changes to diet and exercise, and he can choose to develop healthier behaviors. He may also be better able to follow through on effective behaviors due to superior understanding of how to count calories or do other number-related tasks. In another example, imagine a 50-year-old woman with no family history of breast cancer. Although her known risk factors are low, if she is highly numerate, she may understand that the inherent variability and randomness of health risks still means she is at risk. Understanding that risk, she may be more likely to pursue recommended screening procedures.

      Apter et al.'s hierarchy focuses on math education and the computational skills necessary to function in a complex environment. Table 2 lists the education-based numeracy skills as discussed by Apter et al. (2008). With respect to NAAL quantitative literacy levels (Below Basic, Basic, Intermediate and Proficient), Table 2's skills do not align directly with particular levels, but Apter et al. (2008) listed the education-based skills in order of difficulty from least to most difficult. Table 2 also includes emergent decision-based numeracy skills adapted from Peters (2012). The two types of skills are separated by a dashed line in Tables 2-5 for clarity.

Table 2. Education-based numeracy skills from Apter et al. (2008) and emergent decision-based numeracy skills adapted from Peters (2012)

	Skill Categories	Numeracy-Related Tasks
Education-Based Numeracy Skills	Basic	Reading numbers, counting, telling time
		Arithmetic operations
	Computational	Estimation of size, trend
		Frequency
		Percent
	Analytical	Problem solving and inferring the mathematical concepts to be applied
		Logic
		Reading tables
		Reading graphs
		Reading maps
	Statistical	Estimating error, uncertainty, variability
		Relative versus absolute
		Risk (cumulative, relative, conditional)
Emergent Decision-Based Numeracy Abilities	Information seeking	Seeking numeric information rather than avoiding it
		Willingness to perform computation
	Attention	More likely to attend to numeric information in a complex display
		Able to disregard irrelevant information presented with numeric information
	Memory	Recall numeric information from memory
	Information sensitivity	Sensitivity to numeric information sources
		Sensitivity to non-numeric information sources when numeric sources are available
	Affective meaning	Derive affective meaning (i.e., a sense of goodness or badness) from numeric information. Note: Affect comes into play when developing preferences and making decisions. NAAL comparison examples do not include choice

Emergent Decision-Based Numeracy Skills

Berkman et al. (2011) concluded that having a theoretical basis to interventions was an important component of effective interventions to reduce health disparities. As a result, we briefly review what is known about the psychological theory underlying numeracy's relation to health decision making. It is thought that numeracy exerts its influence on health outcomes in part through its effects on health decision making (Peters, 2012; Reyna et al. 2009).

Understanding these underlying mechanisms should help in the design of more effective interventions in the future.

Psychological research on numeracy and decision making indicates that numeracy is also associated with emergent decision-based abilities not formally taught in school (see emergent decision-based abilities in Table 2). Previous research has shown that higher numeracy is related (not surprisingly) to more comprehension of provided numeric information in a variety of domains, but it is also associated with a greater likelihood to seek out, attend to, and remember numeric information. Higher numeracy has also been associated with more precise number-related affect, a greater sensitivity to numbers in judgments and decisions, and less influence of non-numerical information (Peters, 2012). Some emergent decision-based numeracy abilities (e.g., more numerate individuals are less susceptible to various framing effects) have previously been identified by Apter et al. as being part of education-based skills and so we leave them categorized as education-based skills.

To begin, the highly numerate appear to be more motivated with respect to numeric information; they are more likely to seek it out whereas less numerate individuals may avoid numeric information (Ancker & Kaufman, 2007; Keller, 2011; Lipkus & Peters, 2009). Such information seeking (and lack of information avoidance) is important when choosing whether to find out about the likelihood of a disease such as breast cancer (and possibly be screened for it) or deciding whether to take a new medication that has less than certain benefits and may cause adverse events. Highly numerate individuals, for example, might be more likely to examine detailed consumer medication information to find out about possible side effects and their associated likelihoods. They may also be more likely to pursue information about how to minimize the likelihood of potential medication side effects (e.g., eating and exercise behaviors when taking Coumadin®). Second, when faced with a complex display of information, higher numeracy is associated with a greater likelihood of attending to provided numeric information (Keller, 2011), as well as a greater ability to ignore irrelevant information (e.g., hospital information not related to the quality of care it offers; Peters, Dieckmann, et al., 2007). In the case of choosing a health plan, less numerate individuals might seek out, attend to, and be more easily influenced by anecdotes that describe the friendliness of an insurance provider's staff (e.g., from a neighbor or in marketing materials). At the same time, they may fail to adequately attend to the large annual deductible or copays required by the plan. In one study, for example, less numerate participants could usually understand which consumer-directed health plan had the lowest monthly premiums (we estimate this task to require Below Basic ability), but only about a third of them were able to identify which health plan was better if the patient needed a lot of care (a more difficult task that likely requires at least Intermediate ability; Greene et al., 2008).

Highly numerate individuals also remember numeric information better than the less numerate (Sagara, 2009). Such numeracy effects, however, may be greatest soon after learning health information and then lessen over time. Galesic and Garcia-Retamero (2011), for example, studied how well participants recalled the consequences of health-related behaviors, such as being overweight or exercising, and cardiovascular health. Such recall may be important to following through on recommended behaviors. They found that highly numerate individuals recalled the consequences of health-related behaviors better than the less numerate after 10 minutes. Memory for both groups had declined after three weeks, and no statistically significant memory differences existed between the groups at this later time point. Of course, even the short term memory advantage could be helpful in following the complex treatment plans required in management of chronic diseases such as diabetes. In these cases, patients either have to

remember pertinent numeric information (carbohydrate consumption, blood glucose levels, insulin doses, times administered etc.) in order to take the next step in managing their disease effectively, or they have to be diligent about recording it in the moment.

Previous research also has shown that highly numerate individuals draw more precise affective meaning from numbers than less numerate individuals. Using a paradigm modified from Denes-Raj and Epstein (1994), Peters et al. (2006) presented participants with drawings of two bowls of jellybeans with different numbers of red and white jellybeans. Participants were told to imagine they could pick one bean and they would win $5 if the bean they selected was red. The larger bowl of 100 jellybeans had a higher number, but a smaller proportion (9 in 100 or 9%) of red jellybeans than the smaller bowl. The smaller bowl of 10 jelly beans had one red jellybean and a larger proportion (1 in 10 or 10%) of red jellybeans. Both bowls had the objective percentage of colored jelly beans labeled under each bowl. Participants were asked which bowl they would prefer to choose from and how clear a feeling they had about the goodness or badness of the larger bowl's 9% chance of winning. Peters et al. found that the less numerate were more likely to choose bowl A, the suboptimal choice, than were more numerate individuals. The reason for this difference appeared to be that highly numerate individuals developed more precise feelings about the 9% chance of winning than the less numerate.

Being able to derive affective meaning from numbers and number comparisons is important in a health environment to compare treatment effectiveness or health-care costs. Individuals can have strong affective reactions to risk and other numeric information, and this affect appears to guide risk perceptions and decisions (Slovic, Peters, Finucane, & MacGregor, 2005; Zikmund-Fisher, Fagerlin, & Ubel, 2010). Studies have shown that without affect, numbers are not used in judgment and choice (Bateman, Dent, Peters, et al., 2007; Peters, Vastfjall, et al., 2006). In one study, for example, Fagerlin, Zikmund-Fisher, and Ubel (2005) found that women asked to estimate their risk of breast cancer tended to overestimate that risk. Then, when told their actual risk, these women appeared to draw affective meaning from the number comparison. Compared to women who had not estimated their own risk first, they were quite relieved and perceived their cancer risk as lower than when they were simply told their cancer risk without having made their own estimate first. This is important because it may help to explain why counseling women about breast cancer risks decreases screening compliance. Although numeracy was not explicitly studied, highly numerate women may be more likely to show this and similar effects. As a result, although having greater numeracy generally leads to superior judgments and decisions because they are more likely to attend to numbers and number comparisons and derive affective meaning to guide their choices (Peters et al., 2006), the highly numerate may sometimes demonstrate worse judgments than the less numerate.

Perhaps because of their greater abilities to attend to numeric information and draw affective meaning from it, highly numerate individuals tend to show a greater sensitivity to numeric information in health compared to the less numerate. For example, Lipkus et al. (2010) presented women with early-stage breast cancer with their chances of being cancer free during the next 10 years under four preventive cancer treatment decisions. They found that more numerate patients were sensitive to differences in cancer-free survival estimates for the treatments (they perceived themselves, on average, as more likely to survive when provided higher survival chances such as 92% than lower chances such as 63%); perceptions of the less numerate patients were almost completely insensitive to these same differences in survival odds. Among the women with the highest provided survival odds (average survival odds were about 92%), the less numerate were very pessimistic and perceived their 10-year survival odds as quite

low on average (less than 45%); the highly numerate were also pessimistic, but perceived their odds as considerably higher (more than 75%).

The differences in sensitivity to numbers may also cause (or be caused by; the research is not clear on this point) an opposing difference in sensitivity to non-numeric information. In contrast to the highly numerate, less numerate individuals have shown a greater sensitivity to non-numeric and often emotional sources of information such as provided information frames (survival vs mortality rates are potential sources of emotion) and current mood states. In a study by Västfjäll, Peters, and Starmer (in preparation), researchers manipulated participants' moods to be either positive or negative using a presumably unrelated recall task and then asked participants to price a lottery ticket. Results indicated that less numerate participants were more influenced by the mood induction than highly numerate participants. In particular, the less numerate participants set higher prices for the lottery ticket in the positive-mood condition than the negative mood condition. This is important because patients and consumers make many health judgments and decisions while in emotional states (e.g., the joy of a positive result; the anxiety of a new diagnosis). In Peters, Dieckmann, et al. (2009), less numerate participants also relied on their moods to judge the quality of care of a hospital rather than using provided numeric quality-of-care indicators; the highly numerate used some of the provided numeric information and did not rely on their mood states in the moment.

Thus, previous research has shown that greater numeracy generally leads to better decision making. More numerate individuals tend to understand numbers better than the less numerate (and comprehension is a fundamental building block of good decisions). In addition, however, greater numeracy has been associated with a greater likelihood to seek out, attend to, and remember numeric information, to derive more precise number-related affect, to be more sensitive to numbers in judgments and decisions, and to be less influenced by non-numerical information (Peters, 2012). In general, the highly numerate do more work with numbers than do the less numerate, and these habits of the mind appear to coalesce and allow them to make superior number-based decisions.

The emergent decision-based abilities have not been linked explicitly with the four NAAL quantitative literacy levels. The extant research, however, supports these emergent abilities being present more among highly numerate individuals than the less numerate. As a result, individuals with higher levels of quantitative literacy will tend to exhibit more of these abilities. In particular, the emergent numeracy abilities are likely to be associated with either Intermediate or Proficient quantitative literacy levels. These abilities, however, can also emerge due to experience and/or motivation; individuals with lower numeracy will sometimes use these abilities nonetheless (e.g., and seek out numeric information) if they have had experience in the health domain and understand its importance or if they are motivated in some other way (Hibbard, Peters, et al., 2007). Women, for example, although less numerate on average than men, often show what is likely a health-care-experience-based gender advantage (i.e., women tend to be more involved in family health decisions; Ben-Joseph et al., 2009; Hibbard, Peters, et al., 2007).

Below we provide additional health examples in the three requested areas (following medication instructions, making health-plan choices, and choosing treatments). We also attempt to match the examples, where possible, to the four levels of quantitative literacy identified in the NAAL to provide the reader with an idea of the approximate proportion of the previously uninsured population who will likely be able to do each task.

Example Skills Needed to Select a Health Plan at Each Level of Quantitative Literacy

The Patient Protection and Affordable Care Act (section 1302) broadly defines the levels of coverage and the essential health benefits that must be included in new health insurance plans. It also leaves considerable room for variation between plans. Bronze, Silver, Gold and Platinum plans must, respectively, cover 60%, 70%, 80% and 90% of the value of the benefits included in the plan, but a great deal of flexibility exists in how plans are implemented. Consumers are faced with financial decisions based on premiums, co-payments, co-insurances and annual deductibles. The broad definition of essential health benefits also allows for variation in the services covered, adding another layer of complexity to the decision process.

Table 3 provides examples of tasks related to health plan selection that patients should be able to complete at each level of quantitative literacy. For each example, a comparative NAAL task is included for reference along with relevant skill categories from Table 2 that we believe are needed to perform the task listed. Note that, as in Table 2, the education-based skills and emergent decision-based skills are separated by a dashed line (education-based skills are above the dashed line in each row; emergent decision-based skills are below).

In order to make a health-plan choice, consumers first must be able to locate and understand relevant pricing information. This initial task can be complicated by unfamiliarity with terms such as copay and coinsurance (Quincy, 2012). However, most consumers (even those with Below Basic ability) should be able to locate information although one should keep in mind that the Below Basic group includes individuals with very low-level skills. In fact, previous attempts to assess how well younger and middle-aged adults locate cost and quality-of-care information in tables and charts indicate that about 9% errors might be expected even at this basic building block of the health-plan selection process (Hibbard, Slovic, et al., 2001). It is not entirely clear how to adjust this finding for the group of previously uninsured individuals who will soon be making these choices although the proportion of comprehension errors will be largest in the Below Basic group.

To compare different plans, consumers must be able to calculate differences in monthly premiums; this is expected to be a Below Basic skill that most consumers can perform successfully (see Table 3 for the tasks and relevant skill categories). Selecting the health plan with the lowest cost based on the annual premium and deductible for a family is expected to be a Basic skill doable by about 71% of the uninsured population (everyone except those at the Below Basic level). With at least an Intermediate level of NAAL performance, more comprehensive evaluations of health plan costs are more likely, including such calculations as coinsurance costs based on a percentage of the cost of treatments. More complex calculations (e.g., calculating annual costs based on monthly premiums, estimated out-of-pocket expenses from flat-rate copayments and estimated out-of-pocket expenses from percentage-based coinsurance amounts that meet annual deductibles), however, require much greater proficiency and only an estimated 8.6% of the currently uninsured population is expected to have reached this Proficient quantitative literacy level. Moreover, consumers must be able to estimate their own future health-care needs. For example, a patient with a chronic illness, such as asthma, needs multiple prescription drugs and may be best served by a plan with higher monthly premiums that covers a greater percentage of prescription-drug costs. To determine which health plan best meets her needs, the patient must recall how much each prescription costs her and how many prescriptions she fills per year, add together the cost of these prescriptions, calculate the annual premium amount, and then calculate total costs for each plan and compare the total cost across multiple

plan offerings. This is also expected to require Proficient quantitative literacy. Given the small proportion of individuals at the Proficient level in both the insured and uninsured groups (see Table 1), it is not surprising that researchers have found consumers to be anxious, confused, and overwhelmed when it comes to making health-plan choices (Day & Nadash, 2012; Quincy, 2012).

Table 3. Health-plan selection: Example tasks

Quantitative Literacy Level	Comparative NAAL item	Example Task: Health Plan Selection	Skill Categories (from Table 2)
Below Basic (28.8% of uninsured population)	Calculate the price difference between two appliances, using information in a table that includes price and other information about the appliances.	Compare and calculate the difference between monthly premiums of two plans	Basic; Analytical ―――――――― Information Seeking; Attention
Basic (33.4% of uninsured population)	Calculate the cost of a sandwich and salad, using prices from a menu.	Select the health plan with the lowest cost based on the annual premium and annual deductible for a family.	Basic; Computational; Analytical ―――――――― Information Seeking; Attention; Memory
Intermediate (29.3% of uninsured population)	Calculate the cost of raising a child for a year in a family with a specified income, based on a newspaper article that provides the percentage of a typical family's budget that goes toward raising children.	Calculate the co-insurance cost of an emergency room visit bill for $500 from a table of different co-insurance rates.	Basic; Computational; Analytical ―――――――― Information Seeking; Attention
Proficient (8.6% of uninsured population)	Calculate an employee's share of health insurance costs for a year, using a table that shows how the employee's monthly cost varies with income and family size.	Estimate total annual cost of the health plan including premiums, copays, and deductibles based on expected health-care needs (e.g., estimating costs due to chronic illnesses such as diabetes or asthma).	Basic; Computational; Analytical; Statistical ―――――――― Information Seeking; Attention; Memory; Information Sensitivity,

Beyond the difficulties posed in making the calculations to compare different health plans, individuals with Below Basic performance may be more prone than other individuals to focus on the most salient cost involved in health insurance, which, based on an analysis of Medicare Part D choices, is likely to be monthly premiums rather than out-of-pocket expenses

(Abaluck & Gruber, 2011). Such patients may simply choose the plan with the lowest premium, not understanding that their total annual cost of services may be much higher than another plan with only slightly higher premiums (see also Greene et al., 2008).

Example Skills Needed to Select Treatments at Each Level of Quantitative Literacy

Although decisions among health plans may rely largely on price calculations and comparisons, the decision of which treatment to choose is much less likely to include price as a component. This difference is primarily due to the ambiguity and variability of treatment costs and difficulty in obtaining them. Patients frequently do not receive cost information before treatments are administered (and may find out about or pay attention to only their portion of the costs afterwards). Moreover, recent data highlighted the extreme price variability that exists between hospitals for similar treatments (Centers for Medicare & Medicaid Services, 2013). As a result, even when patients want to evaluate treatment cost differences, accurate cost information can be complicated and difficult to obtain (Rosenthal, Lu & Cram, 2013). Treatment decisions tend to be based instead on the health-care provider's recommendation and (when patients share in the decision) on the convenience of administration, medication co-payments, and perceived risks and benefits of treatment options.

Table 4 provides example NAAL tasks paired with treatment decision tasks estimated to fall into each performance level of quantitative literacy; relevant skill categories are also included. As in previous tables, the education-based skills and emergent decision-based skills are separated by a dashed line (education-based skills above, emergent decision-based skills below). Since the NAAL examples focus heavily on calculations of costs, the examples are not directly matched with our treatment option example tasks. In each example, the patient must be able and willing to seek out numeric information and attend to it; such ability and willingness could be derived from numeracy skills or from a motivation to care for the self or others (e.g., patient activation; Hibbard, Mahoney, Stock, & Tusler, 2007). Most patients, including those with Below Basic performance, likely will be able to compare the co-pay amounts between a generic and name brand prescription drug. With at least a Basic level of quantitative literacy (an estimated 71.2% of the uninsured population), patients should be able to calculate the difference in survival rates between two treatment options when provided with the percentage of patients who survive. Having at least Intermediate quantitative literacy (an estimated 37.9% of the uninsured) would be necessary to complete a medication cost comparison based on the recommended dosage and unit cost of a medication (e.g., comparing the number of pills per dose and cost per pill in generic acetaminophen versus Tylenol in order to choose the less expensive option). Only those with Proficient quantitative skills (an estimated 8.6% of the uninsured) are expected to be able to calculate cumulative risks and benefits of treatments accurately and compare them to make treatment decisions based on tradeoffs that are acceptable to them. For example, a woman with osteopenia might be advised to take a bisphosphonate for 3-5 years but must choose whether or not to take it based on information about annual rates of risks and benefits.

Table 4. Treatment selection: Example tasks

Performance Level	Comparative NAAL item	Example Task: Treatment Selection	Skill Categories (from Table 2)
Below Basic (28.8% of uninsured population)	Compare two prices by identifying the appropriate number and subtracting.	Compare and calculate the difference in co-pay amounts between generic and name brand prescription drugs	Basic; Analytical - - - - - - - - - - - Information Seeking; Attention
Basic (33.4% of uninsured population)	Perform a two-step calculation to find the cost of three baseball tickets, using an order form that gives the price of one ticket and the postage and handling charge.	Calculate the difference in percent of patients who survive one treatment compared to another	Basic; Computational; Analytical; Statistical - - - - - - - - - - - Information Seeking; Attention
Intermediate (29.3% of uninsured population)	Calculate the cost of raising a child for a year in a family with a specified income, based on a newspaper article that provides the percentage of a typical family's budget that goes toward raising children.	Calculate the proportion of patients who will suffer at least one adverse event based on patient age and three possible adverse events (assume independence of adverse events)	Basic; Computational; Analytical - - - - - - - - - - - Information Seeking; Attention;
Proficient (8.6% of uninsured population)	Calculate the yearly cost of a specified amount of life insurance, using a table that gives cost by month for each $1,000 of coverage.	Calculate the five-year risk of fracture from an osteoporosis medication for a female patient of a given age, using a table that gives annual risk for each gender by age group	Basic; Computational; Analytical; Statistical - - - - - - - - - - - Information Seeking; Attention

Example Skills Needed to Understand Medication Instructions at Each Level of Quantitative Literacy

Properly following medication instructions can be a difficult task for some patients (e.g., taking a prescription drug in their own homes). Although prescription drugs are labeled with dosage instructions, patients must be able to read and understand them, remember what time to take any medication, determine how to handle inadvertently missed doses, and when appropriate, determine when to have prescriptions refilled to avoid running out of daily medications.

Table 5 provides examples of the skills needed to follow medication and treatment instructions at each level of quantitative literacy performance, a comparative NAAL example, and relevant skill categories. Note that, as in Table 2, the education-based skills and emergent decision-based skills are separated by a dashed line (education-based skills above, emergent decision-based skills below). Individuals with Below Basic abilities can be expected to locate the risks of side effects in a table in a decision aid or in a relatively simple insert located on a prescription-drug bottle and to determine which side effect is most likely. With at least a Basic level of performance, patients can be expected to anticipate and plan for medication needs, such as determining how soon a prescription must be ordered based on the number of pills left and the number of pills required each day. One of the NAAL tasks identified as at the Intermediate level performance is a task requiring patients to understand medication information and infer, based on instructions, how to handle a missed dose, taking into consideration the time since their last meal.

The management of chronic diseases such as diabetes and asthma pose particular challenges, even for those with Proficient quantitative literacy. Diabetics must know how to accurately use and understand the readings from glucose meters, and modify their insulin dosage based on glucose levels, level of activity, and carbohydrate content. The information needed to make these calculations is found in a variety of formats such as sliding scales and tables that include nutritional information. Diabetic patients need to be able to perform relatively complex calculations correctly, understand numeric information presented in different formats, and recall numeric information and/or keep an accurate record of it. This combination of tasks is likely more difficult than any of the NAAL examples at the Proficient level. As a result, even the most numerate likely find chronic disease management challenging, although they would perform better than those at lower performance levels.

Table 5. Understanding medication instructions: Example tasks

Performance Level	Comparative NAAL item	Example Task: Understanding Medication and Treatment Instructions	Skill Categories (from Table 2)
Below Basic (28.8% of uninsured population)	Calculate the change from a $20 bill after paying the amount on a receipt.	Locate the risks of different side effects for the medication. Identify which side effect is most likely to occur	Basic; Computational; Analytic --- Information Seeking; Attention
Basic (33.4% of uninsured population)	Perform a two-step calculation to find the cost of three baseball tickets, using an order form that gives the price of one ticket and the postage and handling charge.	24 pills remain in a bottle of prescription medication. If you take 2 pills per day and refilling a prescription can take up to 7 days, in how many days should you order a refill to make sure that you don't run out of your prescription?	Basic; Computational; Analytical --- Information Seeking; Attention
Intermediate (29.3% of uninsured population)	Determine what time a person can take a prescription medication, based on information on the prescription drug label that relates timing of medication to eating.	"The patient forgot to take this medicine before lunch at 12:00 noon. What is the earliest time he can take it in the afternoon? GARFIELD, Robert M. Dr. LUBIN, Michael DOXYCYCLINE 100MG Take one tablet on an empty stomach one hour before a meal or two to three hours after a meal unless otherwise directed by your doctor"	Basic; Analytical --- Information Seeking; Attention; Memory (if time of last meal was not provided);
Proficient (8.6% of uninsured population)	Determine the number of units of flooring required to cover the floor in a room, when the area of the room is not evenly divisible by the units in which the flooring is sold.	Diabetes management – understanding glucose meter readings, interpreting sliding scale regimes, titrating oral medications or insulin, adjusting insulin for carbohydrate content. (Note: this example is much more complex than any of the NAAL examples used, but it is a realistic example of what patients are required to do)	Basic, Computation; Analytical --- Information Seeking; Attention; Memory; Information Sensitivity; Affective Meaning

QUESTION 3: WHAT DO WE KNOW ABOUT HOW PROVIDERS SHOULD COMMUNICATE WITH THOSE WITH LOW NUMERACY SKILLS?

A series of recent papers have reviewed how to present numeric information to maximize informed decision making (e.g., Ancker, Senathirajah, et al., 2006; Apter et al., 2008; Berkman et al., 2011; Fagerlin & Peters, 2011; Fagerlin, Ubel, Smith, & Zikmund-Fisher, 2007; Hibbard & Peters, 2003; Lipkus, 2007; Lipkus & Hollands, 1999; Peters, Hibbard, Slovic, & Dieckmann, 2007). They have come to many of the same conclusions. In this section, we summarize the literature by focusing on five main communication themes that are consistent with the process goals identified in Figure 1 (especially lowering cognitive effort and highlighting meaning) and that are updated based on more recent results with less numerate patients and consumers.
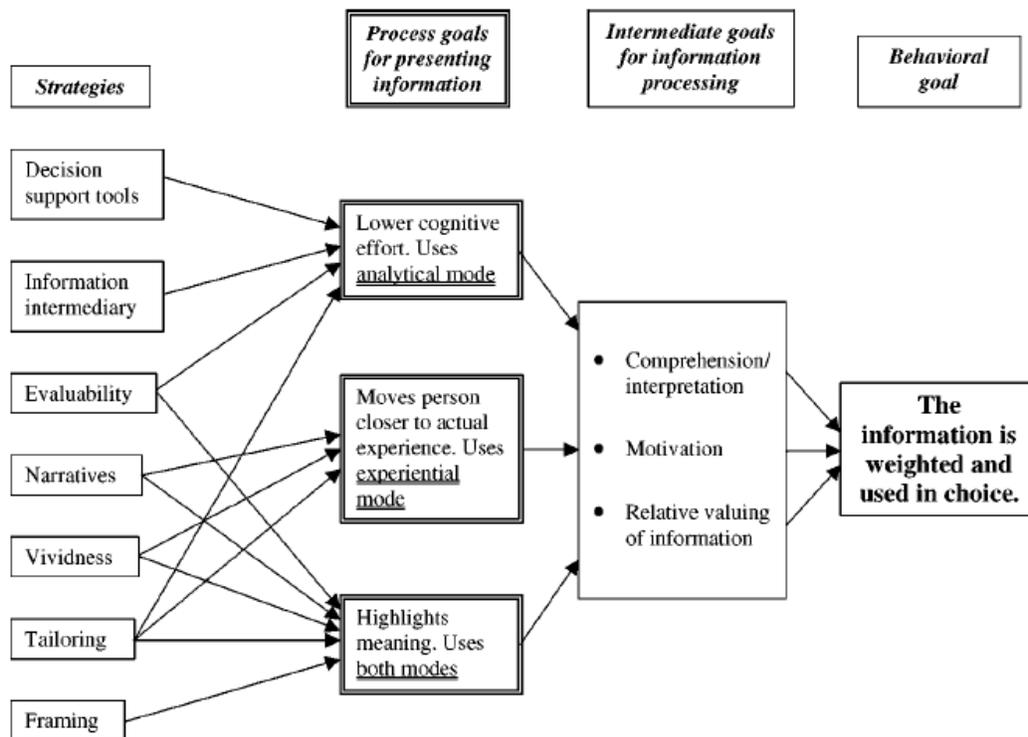

Figure 1. Data presentation approaches that facilitate informed decision making and the use of information in choice (from Hibbard & Peters, 2003)

Communicators should:
- Provide numeric information (as opposed to not provide it)
- Reduce the cognitive effort required from the patient or consumer and require fewer inferences (i.e., do the math for them)
- Provide evaluative meaning, particularly when numeric information is unfamiliar
- Draw attention to important information
- Set up appropriate systems to assist consumers and patients

Most strategies targeted towards the education-based numeracy skills from Table 2 can be found in the section focused on reducing cognitive effort. Strategies targeted at the emergent

decision-based skills are found in the sections on reducing cognitive effort, providing evaluative meaning, and drawing attention to important information. Table 6 summarizes recommended strategies for communicating with patients and consumers with low numeracy skills. In the text that follows, we describe the evidence underlying each of these recommendations.

Table 6. Summary of recommended strategies for communicating with the less numerate.

What communicators should do:	Specific strategies
Provide numeric information (as opposed to not provide it)	Self explanatory
Reduce the cognitive effort required from the patient or consumer and require fewer inferences (i.e., do the math for them)	Provide fewer options Provide less information Present absolute risks, not just relative risks Keep denominators and time spans constant Use numbers consistent with how people use the number line Do the math for them Use appropriate visuals
Provide evaluative meaning, particularly when numeric information is unfamiliar	Carefully use evaluative labels and symbols Carefully use frequency versus percentage formats Use other more imaginable data formats Use emotion to persuade
Draw attention to important information	Order information with the most important information first or last Highlight the meaning of only the most important information Use a framework to provide an overview Use fonts that draw attention to important information
Set up appropriate systems to assist consumers and patients	Identify communication goals Chose information presentation formats strategically Consider the use of defaults options and other choice architecture Use computer-aided decision tools Use information intermediaries

Provide Numeric Information (as Opposed to Not Providing it)

In consumer domains such as purchases of homes and lottery tickets, numeric information (e.g., mortgage rates and likelihoods of winning) is provided to better inform choices. In health domains, numbers are sometimes provided consistently (e.g., copay amounts in insurance choices) but other times are rarely provided (e.g., likelihoods of benefits and side effects when choosing a medical treatment). Providing numbers (compared to not providing them) even in these latter circumstances has been found to influence patient understanding and willingness to take medications in two ways (Berry, 2006; Lipkus, 2007). First, qualitative labels such as "low chance" or "common" are interpreted differently by different people. To one person, common might mean 50% whereas to others it means 25% (Berry, 2006). Second, the

average person tends to overestimate risk likelihood when provided only non-numeric information (e.g., risk labels such as "common," "rare") compared to when they are provided numeric information (Berry, Knapp, & Raynor, 2002; Berry, Knapp, & Raynor, 2003; Berry, Raynor, Knapp, & Bersellini, 2004). Of course, providing numeric information can be problematic, particularly in less numerate populations. As a result, policy makers and others have questioned whether less numerate populations can "handle" numeric information (Schwartz, 2011). Results of a recent study, however, did not support this view (Peters, Hart, Tusler, & Fraenkel, in review). Both more and less numerate respondents were less likely to overestimate risks and were more willing to take the prescribed medication when provided numeric information about medication side effects as opposed to providing only non-numeric information. Although less numerate individuals have more difficulty with numeric information than do the more numerate, they nonetheless benefitted from its provision at least in the context of medication side effects.

The fact that less numerate individuals do have more problems with numeric information, however, emphasizes the need to understand how to provide comprehensible and usable numeric information to them.

Reduce the Cognitive Effort Required from the Patient or Consumer and Require Fewer Inferences from Them (i.e.., Do the Math for Them)

Provide fewer options. A breast cancer communication tool called "Adjuvant Online!" (http://www.adjuvantonline.com) was designed to help oncologists communicate the benefits for patients receiving hormonal therapy and chemotherapy (Ravdin, Siminoff, Davis, et al., 2001). Typically, patients are presented with the risks of no additional treatment, each treatment alone, or both hormonal therapy and chemotherapy. However, for most women, only two choices are appropriate. Zikmund-Fisher and colleagues tested the impact of providing only those two choices and found that, when fewer options were presented, knowledge increased significantly (Zikmund-Fisher, Fagerlin, & Ubel, 2008). Medical and other health experts should identify more and less critical elements of a decision (e.g., dominated options that are worse than other available options on every important dimension) so that information providers can delete them from the consideration set or strategically choose how to present them.

Although having more choice options can have advantages, recent research has pointed towards the notion of a "paradox" or "tyranny" of choice. For example, psychological research has demonstrated that having more options can lead to worse choices and lower satisfaction (Hanoch et al., 2009; Schwartz, 2005). In particular, researchers have suggested that an overabundance of choice can lead to information overload (Huffman & Kahn, 1998; Reutskaja & Hogarth, 2009; Scammon, 1977), decreased motivation, and an inability to choose (Dhar, 1997; Iyengar, Huberman, & Jiang, 2004; Iyengar & Lepper, 2000), decision-related anxiety (Garbarino & Edell, 1997), and outcome dissatisfaction and regret (Botti & McGill, 2006; Schwartz, 2000, 2004). Schwartz et al. (2002) further found that the combination of large choice sets and a desire to choose the best were related to more regret, reduced happiness, and less overall choice satisfaction (Schwartz et al., 2002). The notion of providing fewer options may be particularly relevant to health-plan selection. Numeracy effects have not been studied to the best of our knowledge, but it seems likely that providing fewer options would be especially helpful to the less numerate.

Provide less information. Information is provided to respect consumer and patient autonomy and to help them make better informed decisions. Cognitive drawbacks exist, however, to providing more information. Peters and colleagues tested whether providing lay decision makers with less information, rather than more, could result in the best outcomes (Peters, Dieckmann, et al., 2007). The results indicated that providing less information in hospital quality reports (non-quality-of-care information such as the number of general care beds was removed) resulted in better decision making through improved comprehension and higher quality choices, particularly among participants with lower numeracy skills. Health information providers are faced with a challenge to communicate important content to patients and consumers (e.g., through patient portals and mobile apps) and, simultaneously, not communicate too much content as the presence of extraneous information appears to confuse those who are less numerate (see also Kaminski & Sloutsky, 2013).

Present absolute risks, not just relative risks. When treatment information is presented in a relative risk format (e.g., using hormone replacement therapy doubles the risk of breast cancer), their risks seem larger and treatments are viewed less favorably than when the same information is presented using an absolute risk format (Malenka, Baron, Johansen, Wahrenberger, & Ross, 1993; Forrow, Taylor, & Arnold, 1992; Baron, 1997). This is as true for the lay public as it is for medical students (Chao, Studts, Abell, et al., 2003). Although not studied with respect to numeracy, it is quite likely that effects would be as big or bigger among the less numerate. Other relative risk examples are ambiguous ("Treatment X has a 5% greater risk than Y"). If Treatment Y has an absolute risk of 20%, 5% more risk means that X has a risk of either 21% or 25%. Providing absolute risk numbers disambiguates the situation and reduces cognitive effort and potential confusion by doing the math for the patient.

Keep denominators and time spans constant. Patients experience greater difficult comparing across treatments when different denominators are used (Fagerlin & Peters, 2011). A single denominator should be chosen for comparisons (e.g., 1 in 10,000 and 400 in 10,000 rather than 1 in 10,000 and 4 in 100). In addition, whole numbers (e.g., 1 in 10,000) are better understood than fractions and decimals (.01 in 100). Similar advice exists for time spans. To facilitate comparisons, use the same time frame when presenting risks and benefits (e.g., provide annual costs for all health plans rather than monthly costs for some and annual costs for others).

Use numbers in a direction consistent with people's expectations. Peters, Dieckmann, et al. (2007) found that less numerate consumers, in particular, understood more when provided information requiring less cognitive effort. They presented hospital quality-of-care information either in a format in which a higher number meant better (the number of registered nurses per 100 patients) or in the more usual format where a lower number meant better (the number of patients per registered nurse). Putting the numbers in a direction consistent with people's expectations (i.e., usually higher numbers mean something "better" than lower numbers) facilitated comprehension and helped respondents make better choices. Results were even stronger among the less numerate than among the highly numerate. This concept applies equally to other information formats common in medicine. For example, when explaining risks associated with treatment, some information providers use the Number Needed to Treat (NNT). If considering the benefits of chemotherapy for example, NNT is the number of women needed to take chemoprevention to prevent cancer in one of them; here, larger numbers mean a less

effective treatment. NNT is a difficult format for people to understand and it should not be used with laypeople (and arguably not with physicians either who can also be innumerate; Anderson, Obrecht, Chapman, Driscoll, & Schulkin, 2011; Sheridan & Pignone, 2002).

Do the math for them. When evaluating healthy behaviors such as taking medication, eating better, or exercising more, consumers and patients are often told about risks over one time period and they are expected to extrapolate to other time periods. For example, Nina might be informed of the annual risk of taking birth control pills, but she intends to take them for many years, say 10. Understanding this 10-year risk requires a level of numeracy that most people do not have. In one study, for example, well-educated participants were asked a problem that required a similar mathematical solution "Imagine that, when the Columbus Clippers and the Eugene Emeralds minor league baseball teams have played each other, the Columbus Clippers won only 10% of the time. If the teams have a four-game series, by your calculations, what are the chances that the Clippers will win at least once? (Correct answer: 34%; Peters, Kunreuther, et al., 2012). Only 1% of their college-student sample answered this question correctly. Similar cumulative-risk comprehension issues exist in the long-term false-positive rates from annual cancer screenings in some groups (Gigerenzer, 2002; Sakr et al., 1996; USPSTF, 2011; Welch et al., 2011). Providing estimates for risks over longer time periods by doing the math for consumers would go a long way towards helping them understand the cumulative implications of their choices.

Use appropriate visuals. Presenting event rates with visual aids such as pictographs (also called icon arrays), bar charts, or flow diagrams may aid accurate understanding of numeric information such as probabilities. This appears particularly true in less numerate populations. Visual displays have been shown to reduce several biases, including denominator neglect (Garcia-Retamero, Galesic, & Gigerenzer, 2010), framing effects (Garcia-Retamero & Cokely, 2011), and the use of anecdotes over more reliable statistical information (Fagerlin, Wang, & Ubel, 2005). Icon arrays, in particular, have been tested extensively in recent health-communication research, and some nuances to their use have arisen. For example, the icons should be arranged in blocks (e.g., of those with vs without the disease) rather than being scattered randomly (although scattering them randomly can facilitate the perception of randomness, e.g., who gets a disease). Numerator size may also be an important factor when presenting the changes in numeric outcomes for events out of 1,000 among adults with lower education and literacy (McCaffery, Dixon, Hayen, Jansen, Smith, & Simpson, 2012). Where the outcome is less than 100/1000, icon arrays were better understood and processed more quickly than bar charts, particularly if the difference between event rates was small. However, for more common outcomes (greater than 100/1000), bar charts were better, possibly because the icon arrangement was more complicated. In addition, the role of shading in processing the part-to-whole relationship of icon arrays is still not well understood. Most importantly, usually single icon arrays have been tested, and little is known about the effects of icon arrays in those health situations that would likely require integration across multiple arrays (e.g., displaying the ten possible adverse effects of a prescribed medication). It seems probable that the complexity of multiple icon arrays would disadvantage the less numerate in particular.

Finally, some graphs appeared better suited for particular tasks (e.g., line graphs for trends over time, bar graphs for comparison across groups; Lipkus, 2007; Lipkus & Hollands, 1999). One final note: Just because consumers or patients prefer some graphs does not necessarily mean that they will understand them better than non-preferred graphs. For an

excellent systematic review of the use of graphs in health communication (that did not focus on numeracy, however), see Ancker et al. (2006).

Provide Evaluative Meaning or Highlight Meaning

Some of the approaches recommended above lower cognitive effort by providing cues to transform the information to an evaluative good/bad scale (Hsee, 1996, 1998). Instead of having to think hard about how to evaluate the goodness or badness of information about an option, an evaluable display reduces the analytical effort required by providing these evaluations in a simpler form. It also may motivate further information processing and behaviors (Peters, Dieckmann, et al., 2009). The concept of evaluability is simple but profound. Information varies in the degree to which it conveys evaluative meaning. Particularly in unfamiliar domains, we may not know what a measure means (e.g., a measure of quality of care, expressed by the percentage of people satisfied with their care). Research on evaluability demonstrates that even if we understand the numbers used (e.g., a medication that has a 2% elevated risk of stroke) at some fundamental level, we may not have an emotional or affective understanding of it (e.g., we do not know how bad this elevated risk is). And when information lacks emotional meaning, it lacks evaluability and is not weighted properly in decision-making (Slovic, Finucane, Peters, & MacGregor, 2002). We can determine meaning through considerable effort in comparing and contrasting available information; this is especially true for the highly numerate (Peters, Vastfjall, et al., 2006). However, it appears that consumers do not always go to this extra effort and may rely instead on information that is a priori more evaluable. In health contexts, for example, money may be one of the variables that is most evaluable and easily understood; other important variables such as quality-of-care measures are less evaluable and, thus, are less weighted in choice despite their importance to the long-term quality of our health-care system. As we will review, however, information evaluability can be improved in a variety of ways. By improving evaluability, we can lower the effort required of the analytical system and highlight the meaning of the information at the same time.

Altering the evaluability of information means that we can help consumers transform data into meaningful information and, by so doing, affect the degree to which the information is actually used in choice (Hibbard, Slovic, Peters, & Finucane, 2002). These evaluability changes make all of the information about a choice available in a simple good/bad form (so that consumers can compare apples to apples). This simpler information then influences the interpretation and comprehension of information about the choice attributes. By providing information in an explicitly evaluative form, it can be used more easily to evaluate the overall goodness or badness of any one option. Experimental findings indicate that evaluable displays of comparative data influence the degree to which information such as quality of care is actually weighted and used in choice.

Carefully use evaluative labels and symbols. People making decisions can be quite poor at using numeric information in making decisions. Interpreting the meaning of numeric information (e.g., tell patients how good or bad a 9% risk is) can have a robust influence in health judgments and choices across diverse adult populations (Peters, Dieckmann, et al., 2009). In one series of studies, providing evaluative labels (poor, fair, good, and excellent) with numeric quality-of-care information resulted in its greater use in judgments and less reliance on an irrelevant affective state among the less numerate. Follow-up studies in this paper demonstrated that consumers given evaluative labels processed the numeric information (and did not ignore it due to the

presence of labels). Instead, the evaluative labels appeared to increase the relative accessibility of valenced feelings about the choice options over valenced thoughts about the same options. In another study, evaluative labels for test results (that a test came back "positive" or "abnormal") induced larger changes to risk perceptions and behavioral intentions than did numeric results alone (Zikmund-Fisher, Fagerlin, et al., 2007). The normative appropriateness of changes in this latter study were unclear, however, thus highlighting that evaluative labels should be applied with great care.

Carefully use frequency vs percentage formats. The choice between frequencies and percentages can affect people's perceptions of provided information, especially risk information (Slovic, Monahan, & MacGregor, 2000). For instance, Peters and colleagues asked participants to imagine they had severe headaches and that a medicine existed that could decrease headache frequency (Peters, Hart, & Fraenkel, 2011). Participants read about a possible side effect of the drug in a percentage format (10% of patients get a blistering rash) or in a frequency format (10 patients out of 100 get a blistering rash). Less numerate participants (but not the highly numerate) perceived the medicine as less risky when side-effect information was presented using percentages rather than frequencies. Peters et al. interpreted their results as being due to the frequency formats eliciting greater emotional imagery compared to percentage formats (thought to be perceived as relatively abstract and meaningless). Because information providers have to choose some format to provide likelihood information (and no format is neutral), they should think carefully about whether they would recommend taking a medication that has a possible side effect (in which case, they should use a percentage format in conveying possible risks) or they think the patient should seriously consider the side effect (they might use a frequency format instead). The choice of format will make little difference to the highly numerate but will matter to the less numerate (see also Dieckmann, Slovic, & Peters, 2009; Peters, Vastfjall, et al., 2006).

Use other more imaginable data formats. Just as data presented in a frequentistic format may be easier (and more emotional) to imagine than presented in a probabilistic format, changes in life expectancy appear easier to imagine than changes in disease risk. Galesic and Garcia-Retamero (2011) found that, when information about consequences of risky behaviors was presented as months of life lost or gained, recall was better than when it was presented in terms of risks of a disease. The effect held for both short-term and longer term memory for the information and for individuals higher and lower in numeracy. The improved recall seemed to be due to better imaginability of changes in life expectancy. These results are consistent with recent research demonstrating an effect of displaying the minutes of brisk walking needed to burn calories for menu items (as opposed to having only calorie counts) on how many calories were ordered and consumed (James, Adams-Huet, Crisp, Mitchell, Dar, Turner, Kasper, et al., 2013).

Use emotion to persuade. Diverse studies have demonstrated that affective reactions are powerful sources of information when deriving perceptions of risk (Loewenstein, Weber, Hsee, & Welch, 2001; Slovic, Finucane, Peters, & MacGregor, 2004). Emotional manipulations can influence risk evaluations (Loewenstein et al., 2001; Slovic, Finucane, et al., 2004) and increase thoughts about behavioral change (Diefenbach, Miller, & Daly, 1999; Romer & Jamieson, 2001). Tobacco, for example, is the leading cause of preventable death worldwide, killing one person every six seconds (Centers for Disease Control and Prevention, 2012; World Health

Organization, 2012). To combat this epidemic, some countries have implemented health warnings on the front and back of cigarette packages that include basic statements of health risks (e.g., "smoking kills") and large graphic images illustrating the risks. In contrast to basic text-only warnings, which are forgettable and ineffective (Bansal-Travers, Hammond, Smith, & Cummings, 2011; Borland et al., 2009; Hammond et al., 2007; Moodie, MacKintosh, & Hammond, 2009), graphic pictorial warnings create negative affect toward smoking (Peters et al., 2007) and encourage smokers with those reactions to think about quitting (Hammond, 2011; White, Webster, & Wakefield, 2008). It is thought that the graphic labels may have greater effects among less educated (including less numerate) populations. Health-care providers should consider the use of emotion such as with graphic verbal or visual representations in situations where persuasion is an acceptable tool.

Draw Attention to Important Information

Order information so that the most important information is first or last. Ordering information can help consumers by reducing the cognitive effort required to locate and understand the goodness or badness of information and by drawing attention to important information. Hibbard, Slovic, et al. (2002), for example, found that ordering health plans by performance within premium cost strata resulted in more choices of higher-performing plans compared with presenting the information unordered. It is not clear from the literature whether ordering might have a differential effect based on consumer numeracy level, but it is likely that the effect is larger among the less numerate who generally have more difficulty understanding the meaning of numeric information.

Highlight the meaning of only the most important information. In Peters, Dieckmann, et al. (2007), making only a more important quality measure easier to evaluate through the use of evaluative symbols such as those used by Consumer Reports (rather than making all indicators easier to evaluate) led to more choices of higher-quality hospitals. These results were particularly strong among the less numerate. When the meaning of nonessential information is highlighted (along with more important information being highlighted), it may actually worsen health choices among those with lower numeracy.

Use a framework to provide an overview. Greene, Peters, Mertz, and Hibbard (2008) examined consumer understanding and use of information when making a choice between a more familiar type of health plan and a less familiar one. They found that less numerate consumers understood less of the information provided about the new type of health plan at the same time as they were substantially more likely to choose it. Providing an overarching framework to explain and highlight the differences between the two types of health plans boosted comprehension on items related to the framework message. However, it reduced comprehension on items that were not related to the framework, particularly among the less numerate. The study highlighted the difficulty many consumers, and especially the less numerate, have in understanding comparative plan information and in making informed health-care choices similar to what will be provided as a result of the ACA. Providing a framework can help, but information providers will need to take care that all important information is mentioned in the framework (with the more detailed information following the framework) to ensure comprehension among the less numerate.

Use fonts that draw attention to important information. One reason that health information may not be used is because consumers never attended to it in the first place. With numeric information, this may be particularly true for less numerate consumers (see review of attention effects in the section on emergent decision-based numeracy skills). Methods can be used, however, to explicitly draw attention to numeric information in these cases. Stimuli that are perceptually salient draw attention (Parkhurst, Law, & Nieber, 2002) and tend to have greater influence on choice (Bettman, Luce, & Payne, 1998). For example, in a men's clothing store, a red tie placed in a display of neutrally colored ties may capture attention and be chosen more often than the same red tie in a display of vibrant colors.

The visual salience of health information can be manipulated in a variety of ways including through larger or bold fonts. In an unpublished dissertation, for example, Sagara (2009) found that participants were more sensitive to different levels of numeric information when the numbers were printed in a font that contrasted more with other provided information. In particular, numeric product information that was italicized and printed in grey (in contrast with the regular black font of the surrounding information) appeared to increase the salience of the numeric information, and to result in a greater impact of the numbers on participants' product judgments. In two studies in an unpublished Master's thesis, Meilleur (2012) varied the risks associated with a vaccination and the font size in which the risks were printed to increase salience and draw attention to the risks. Meilleur found that increasing the font size of the numeric risk information drew participant attention towards it, increased their sensitivity to risk, and altered vaccination decisions.

Set Up Appropriate Systems

Identify the goals of the communication. To communicate effectively, communicators (whether health-care providers or insurance providers) need to identify the goal or goals of a communication and what information the decision maker needs to receive. Without this identification of what matters and to whom, communication efforts will be inadequate. For the previously uninsured population, low numeracy is likely to be an issue. Communication efforts (how to present information) should address this issue in an evidence-based manner. For each type of decision the previously uninsured population will need to make, effective communication will depend in part on identifying information that is more and less important and identifying options that are dominated and dominant. Doing so will allow communicators to take some of the recommended steps to reduce cognitive effort, highlight evaluative meaning, and draw attention to important information in ways that facilitate appropriate comprehension and use of numeric information.

Information presentation formats. Communication should be viewed as a strategic process that begins with identifying what information the patient or consumer should know and use or wants to know and use. Then information presentation should proceed in an evidence-based manner to best reach the identified communication goals. One of the most important points is that communications should be tested prior to their use and in appropriate populations (e.g., in a less numerate population if that is the ultimate target for the communication).

Default options and other choice architecture. If a health provider wants to promote behavior change (as opposed to simply inform a patient or consumer), the notion of choice architecture offers alternative approaches to promoting better health decisions. Choice architecture is a term coined by Thaler and Sunstein (2008) that reflects the fact that many ways exist to present a choice to decision makers, and that what is chosen often depends upon how the choice is presented. Although few of these tools have been examined with respect to individual differences such as numeracy, they hold some promise. Johnson, Shu, et al. (2012) provide a brief review that identifies, describes, and categorizes some of the many tools that could be tested within health environments.

One of the primary tools tested thus far is the use of default options. Defaults are choice options that are chosen a priori by policy makers and that are applied to individuals who do not take active steps to change away from them (Brown & Krishna, 2004). The default is "chosen" if the consumer does nothing. These are already in wide use; consider, for example, a physician who has a recommended treatment. She usually just writes out the appropriate prescription at that point although the patient could continue to discuss alternative treatments. Defaults have been shown to have strong effects on choices concerning investments (Cronqvist & Thaler, 2004; Madrian & Shea, 2001), insurance (Johnson et al., 2003), and organ donation (Johnson & Goldstein, 2003). They appeal to a wide audience in their ability to guide choice while preserving freedom of choice. In another example, providing calorie information has not consistently improved individuals' food choices. However, providing healthy default options on a menu has significantly increased choices of lower-calorie foods (Wisdom, Downs, & Loewenstein, 2010). Greater use of defaults may be particularly useful in health-insurance selection to encourage enrollment and, if defaults are carefully selected, result in consumers who are more likely to be satisfied with their choice.

Computer-aided decision tools. Health-care and related providers do not need to be the sole communicators with the ACA population. Many of the same strategies (e.g., reducing cognitive burden and highlighting meaning) can be accomplished through the use of carefully designed computer-aided decision tools. Use of such tools can structure and simplify the decision process at the same time as important factors and tradeoffs are highlighted for consideration. Calculators (e.g., for health plan costs for those needing a lot of health care because of chronic disease or those expecting few health-care costs) can be built into such tools or can be provided as stand-alone tools. Such strategies may be quite important given the small proportion of the ACA population expected to have Proficient levels of quantitative literacy and to be able to perform such calculations (see Table 3).

Intermediary. Individuals sometimes require greater assistance, particularly individuals with less computer experience, lower numeracy, and other limitations with respect to health literacy. An information intermediary can perform a similar, but more personalized, function to computer-aided decision tools.

CONCLUSIONS

The expected influx of previously uninsured individuals into our nation's health-care system will present a variety of challenges including the challenges of communicating with less numerate individuals who have limited knowledge and abilities to navigate this unfamiliar and often numeric world. This population will vary considerably in education-based numeracy skills (from basic arithmetic to understanding cumulative risk) and emergent decision-based numeracy skills (from seeking out numeric information to deriving affective meaning from it). Providers have an opportunity in the coming months and years to better understand who these people are (in terms of their abilities) and to apply the science of communication to help these patients and consumers make informed decisions and maximize their health and wellbeing given new ACA benefits.

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Estimating Quantitative Literacy Levels In U.S. Uninsured Adults

The percentage of Americans without health insurance in 2011 was 15.7% (United States Census Bureau, 2012). Using the 2003 National Assessment of Adult Literacy (NAAL) and 2009-2011 Census Bureau data, we calculated an estimate of the proportion of uninsured and insured American adults that fall into Below Basic, Basic, Intermediate, and Proficient quantitative literacy categories. The 2009-2011 Census Bureau provides data on the proportion of uninsured adults at each level of educational attainment (see Table A1), whereas the 2003 NAAL provides data on the proportion of adults in each quantitative literacy level by highest educational attainment (see Table A2). The sample from the NAAL consists of people 16 years of age and older living in households or prisons whereas the sample of uninsured from the 2009-2011 Census consists of noninstitutionalized civilian adults ages 25 and older. Thus, our comparison is imperfect although it nonetheless gives an idea of the relative difference in quantitative literacy skills in patients and consumers that the health-care system sees now (insured adults) and will likely see soon (previously uninsured adults). Additionally, according to the 2009-2011 Census, less than 1% (0.8%) of the uninsured population is age 65 and older; as a result, our estimated proportions in the uninsured group would not change drastically if we had been able exclude older adults.

Among uninsured adults, we estimated that 28.8% are at the Below Basic level, 33.4% are at the Basic level, 29.3% are at the Intermediate level, and 8.6% are at the Proficient level (Table A3). We calculated this estimate first by multiplying the proportion of uninsured adults at each level of education attainment (from Table A1) by the proportion of adults in each quantitative level at every level of education attainment (from Table A2). Next, we summed the proportions within each quantitative literacy level (across education levels) to get a total estimate of the proportion of uninsured at each level (Table A3).

Table A1. 2009-2011 Census Bureau Data

Civilian noninstitutionalized population 25 years and over	U.S. population	Margin of	Uninsured	Margin of
Educational attainment	200,227,629	+/- 23,788	31,883,520	+/-127,723
Less than high school graduate	14.1%	+/-0.1	27.2%	+/-0.1
High school graduate, GED, or alternative	28.3%	+/-0.1	34.1%	+/-0.1
Some college or associate's degree	29.0%	+/-0.1	26.9%	+/-0.1
Bachelor's degree or higher	28.6%	+/-0.1	11.9%	+/-0.1
	100.0%		100.1%	

Table A2. 2003 NAAL Quantitative literacy levels by education

Educational attainment	Below Basic	Basic	Intermediate	Proficient	
Less than/some high school	64.0%	25.0%	10.0%	1.0%	100.0%
High school graduate	24.0%	42.0%	29.0%	5.0%	100.0%
Some college	10.0%	36.0%	43.0%	11.0%	100.0%
Bachelors degree	4.0%	22.0%	43.0%	31.0%	100.0%

Table A3. Proportion of uninsured adults at each quantitative literacy level

Educational attainment	Below Basic	Basic	Intermediate	Proficient	
Less than/some high school	17.4%	6.8%	2.7%	0.3%	
High school graduate	8.2%	14.3%	9.9%	1.7%	
Some college	2.7%	9.7%	11.6%	3.0%	
Bachelors degree	0.5%	2.6%	5.1%	3.7%	
% uninsured adults at each quant literacy level	28.8%	33.4%	29.3%	8.6%	100.1%

To estimate the proportion of insured adults that fall into each quantitative literacy category, we used the same procedure. We first calculated the proportion of insured adults at each level of education by using Table 1A. We subtracted the number of uninsured adults from the U.S. population for each education level and then divided that number by the total number of insured adults. Next, we followed the same multiplication and summation computations previously described with the uninsured population, but used the insured proportions.