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Health Literacy, Health Numeracy, and Trust in Doctor: Effects on Key Patient Health Outcomes

This research examines the roles of health literacy, health numeracy, and trust in doctor on: (1) patient anxiety when consulting a doctor; (2) frequency of physician consultations; and (3) patient subjective well-being (SWB). Our sample consisted of 4,040 adults representative of the United States in terms of age, income, and education, but equally split among White/Caucasian (50%) and Black/African American (50%) respondents. We found that functional and communicative health literacy and trust in doctor have linear and curvilinear relationships with anxiety when consulting a doctor. Health numeracy had no effect. Anxiety when consulting a doctor was associated with a lower number of physician consultations and lower SWB. We observed direct linear effects of health literacy, health numeracy, and trust in doctor on frequency of physician consultations and SWB, as well as some curvilinear effects. We found a negative relationship between health numeracy and SWB. We discuss implications of these findings for health and public policy.

In recent years, scholars from disciplines within medicine, health psychology, and consumer behavior have examined the effects of functional and communicative health literacy and health numeracy on several health-related outcomes. Briefly, functional health literacy reflects a patient's basic reading and writing skills pertaining to comprehending health issues, as well as basic knowledge of health conditions. Communicative health literacy refers to a patient's communication skills with regard to extracting information, deriving meaning, and using that information in interactions with health care practitioners (Bishop et al. 2016; Chinn and

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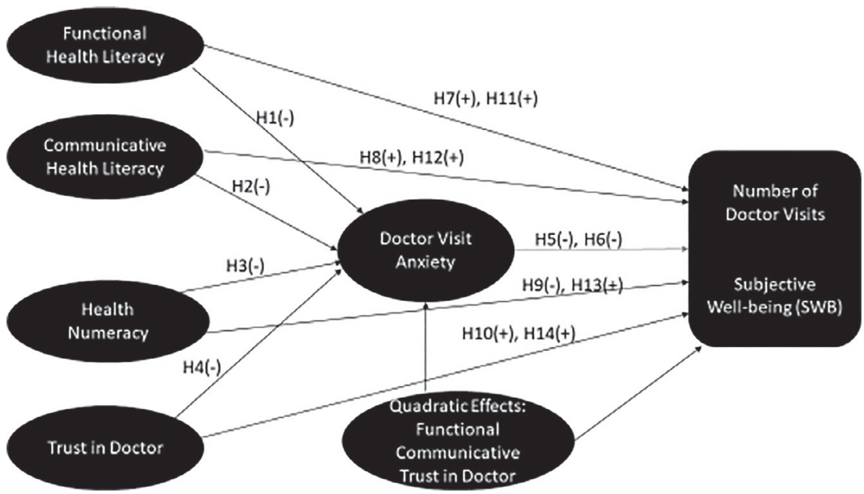
McCarthy 2013). As such, these health literacy constructs are largely perceptual, reflecting *subjective* knowledge pertaining to health care issues. Conversely, health numeracy is a more *objective* assessment of a patients' ability to calculate, use, and understand numeric and quantitative concepts in the context of health care (Levy et al. 2014; Schapira et al. 2014).

It has been estimated that one-third of US adults are considered low in terms of health literacy and/or health numeracy (Mende et al. 2017), with these lower levels more prevalent among the elderly, lower-income and -education groups, and certain racial groups (Atlin et al. 2014; Reyna et al. 2009). Much of the research examining the effects of functional and communicative health literacy and health numeracy have focused on these lower levels, with an emphasis on predicting *negative* health outcomes. These outcomes include a higher use of health care emergency services, lower adherence to health protocols from physicians, inaccurate assessments of disease risks, and lower use of company-sponsored health plans (Adkins and Ozanne 2005; Mende et al. 2017; Zhang, Terry, and McHorney 2014). In addition to these negative health outcomes, estimates of the financial impact of low health literacy and health numeracy are staggering, amounting to $106–$238 billion annually in the United States alone (Vernon et al. 2007).

Far fewer studies have examined the potential *positive* effects of higher levels of health literacy and numeracy. Given the role doctors play in disseminating information affecting functional and communicative health literacy and health numeracy, it is important to examine how these constructs, and the degree of trust patients place in their doctor, may relate to positive health outcomes (Bishop et al. 2016). The present research attempts to model the effects of functional and communicative health literacy, health numeracy, and trust in doctor on the positive outcomes of reducing the anxiety patients feel when consulting a doctor, frequency of physician consultations, and subjective psychological/emotional well-being (SWB).

As shown in Figure 1, we hypothesize that higher levels of the health literacy constructs, health numeracy, and trust in one's doctor (trust in doctor) are associated with a lower level of anxiety patients feel when consulting a doctor (doctor visit anxiety): H1 to H4. We further predict that doctor visit anxiety is negatively related to the frequency of physician consultations (number of doctor visits: H5) and SWB (H6). Figure 1 also hypothesizes a series of incremental effects of the health literacy constructs, health numeracy, and trust in doctor on number of doctor visits (H7 to H10) and SWB (H11 to H14). That is, we hypothesize that the effects of the health literacy constructs, health numeracy, and trust in doctor

FIGURE 1
Health Literacy, Health Numeracy, and Trust in Doctor: Effects on Key Consumer Health Outcomes



on number of doctor visits and SWB are only partially mediated by doctor visit anxiety.

Finally, we test for *potential* curvilinear effects—specifically first-order polynomials or quadratic effects—of the health literacy constructs and trust in doctor on doctor visit anxiety, number of doctor visits, and SWB. In essence, a quadratic effect tests for one bend in the relationship among an independent variable and a dependent variable (Cohen et al. 2003). This bend, or departure from linearity, occurs at either very high or low levels of an independent variable's relationship with the dependent variable. Examining quadratic effects in the present context are important for several reasons.[1]

First, exploring extreme levels of a predictor variable can offer more diagnostic information to communication managers, public health officials, and policymakers than simple linear effects (Andrews, Netemeyer, and Burton 2009). For example, research has shown that at the very highest and lowest levels of customer satisfaction, the customer satisfaction-loyalty

1. Two major types of curvilinear effects that can be examined within a correlational framework are: (1) the quadratic effect (i.e., squaring the independent variable) and (2) the cubic effect. A cubic effect (i.e., taking the independent variable to the third power) suggests two bends in the independent–dependent variable relationship. We had no compelling rationale to explore cubic effects for health literacy or trust in doctor. When we estimated such cubic effects with control variables in the model, none were observed.

link is different from that at moderately high or moderately low levels (Agustin and Singh 2005). This enables marketers to more effectively pinpoint customer relationship strategies, strengthen already strong relationships, and devise strategies for remedying weak relationships.

Second, quadratic effects can be instrumental in finding "tipping points" for well-intentioned policy initiatives (Netemeyer et al. 2015). Andrews, Netemeyer, and Burton (2009) report that consumers with the highest level of nutrition knowledge showed a negative quadratic effect on their intent to buy a product high in negative nutrients, suggesting that policymakers should focus on providing easy-to-understand information on food labels for those at lower knowledge levels. Third, quadratic effects can reveal counter-intuitive effects. Research has shown that some fear-appeals designed to deter a risky behavior (e.g., teen smoking/drinking) may result in reactance effects; at a certain point, the fear → risky behavior link becomes positive rather than negative (Witte and Allen 2000). Thus, the direction of a quadratic may differ from the linear effect, and conclusions drawn from linear effects alone might be misleading.

STUDY CONCEPTS

Health Literacy

There are numerous definitions and measures of health literacy, with many viewing the construct as multidimensional (O'Neill et al. 2014; Osborne et al. 2013). Though there seems to be no universally accepted conceptualization or measure of health literacy, two definitions have recently attracted attention. Batterham et al. (2016, 3) define health literacy as "personal and relational factors that affect a person's ability to acquire, understand, and use information about health and health services," and Bishop et al. (2016, 889) define health literacy as the "ability/capacity to obtain, process, and understand basic health information and services needed to make health decisions."

These two definitions stress what have been referred to as the functional and communicative dimensions of health literacy (Bishop et al. 2016; Chinn and McCarthy 2013). As previously noted, functional health literacy corresponds to basic reading and writing skills pertaining to health issues, as well as basic knowledge of health conditions. As such, functional health literacy broadly reflects the perceived confidence patients have in understanding verbal and written information pertaining to health issues. Communicative health literacy refers to the communication skills necessary to extract information, derive meaning, and use that information in interactions with health care practitioners. The interplay between information and meaning reflect a "two-way" street in which patients must ask relevant questions of their health care provider and the provider (doctor/physician) must ask relevant questions and offer understandable health information to patients (Chinn and McCarthy 2013; Haun et al. 2014; Nutbeam 2008).

Many view health literacy as an empowering mechanism that allows individuals to take better control over their health and take a coproduction role in managing their health care (Mende et al. 2017; Nutbeam 2008). Thus, higher health literacy may allow patients to play a more active role—and in today's health care system a *more expected role*—in affecting their own health, health care, and psychological well-being (Anderson et al. 2016). Based on previous research (Bishop et al. 2016; Chinn and McCarthy 2013; Parker et al. 1995), we developed brief measures of functional (four items) and communicative health literacy (three items) that tap the domains of these constructs. These measures and the procedures used to develop them are detailed in Appendix A.

Health Numeracy

Several measures of health numeracy exist, and some measures of health literacy actually include a numeracy component (e.g., TOHFLA, Parker et al. 1995). In the present research, we treat health numeracy as a separate *objective* construct reflecting the ability to calculate, use, and understand numeric and quantitative concepts in the context of health issues (Levy et al. 2014; Schapira et al. 2014). Health numeracy is akin to the general concept of numeracy, which reflects how skilled and facile individuals are with basic probability and mathematical functions in decision making (Lipkus, Samsa, and Rimer 2001). Numeracy in general has been shown to have positive associations with judgment and decision making across several contexts (Weller et al. 2012).

Given its objective nature, health numeracy is often measured via a series of multiple-choice questions assessing math and quantitative abilities for health-related issues (Osborn et al. 2013; Schapira et al. 2014). Higher scores on health numeracy have been associated with the ability to better understand dosage in medication, more accurately assessing the risks of various diseases, and a greater ability to adhere to treatment plans (Reyna et al. 2009). Still, health numeracy has not received the same attention as health literacy in affecting health behaviors, and though both health numeracy and health literacy are considered necessary to a patient's understanding and treatment of health issues, the two have rarely been studied in tandem as separate constructs having separate effects on positive health outcomes.

Based on the prior work of Osborn et al. (2013) and Schapira et al. (2014), we develop an 8-item health numeracy measure that assesses a patient's ability to calculate, use, and understand numeric concepts in the context of health issues. This measure and the procedures used to develop it are also detailed in Appendix A.

Trust in Doctor

Though there are many individuals involved in providing frontline health care (e.g., nurses, physician assistants, medical technology professionals, hospital administrators), our study focuses on trust in doctors/physicians, as they are still viewed by patients as playing the most critical role in providing health care (Dang et al. 2017; Dugan, Trachtenberg, and Hall 2005). Trust is a key factor in any exchange relationship and is critical for establishing and maintaining long-term relationships between service provider and customer (Doney and Cannon 1997). In the realm of health care, patient trust in physicians is considered a core feature in predicting patient satisfaction, adherence to treatment regimens, better physical health outcomes, and the willingness to seek physician care and advice regularly (Bachinger, Kolk, and Smets 2009; Dugan, Trachtenberg, and Hall 2005; Roth 1994).

Consistent with the research in services and health care marketing (Doney and Cannon 1997; Dugan, Trachtenberg, and Hall 2005), the current research views trust in doctor (either primary care provider or the doctor consulted most often) as the optimistic acceptance of information and treatment, in which the patient believes that the doctor will act in the patient's best interest. Viewing trust in doctor in such a manner recognizes the vulnerability of the patient in patient–doctor interactions, the imbalance of power and expertise in such interactions, and ultimately what is at stake for the patient: both physical health and psychological well-being (Dugan, Trachtenberg, and Hall 2005). We use the well-validated 5-item patient trust in physician scale by Dugan, Trachtenberg, and Hall (2005) to measure trust in doctor.

Doctor Visit Anxiety

We define the anxiety patients experience upon consulting a physician as situation-specific anxiety: the worry, uncertainty, anxiety, and dread patients may feel during doctor–patient consultations. Though related to general trait and state anxiety (Marteau and Bekker 1992), situation-specific anxiety is triggered by a set of stimuli tied to a specific event or experience (Ellis 2008). Such anxiety is most prevalent when patients anticipate a negative health diagnosis (van Osch et al. 2014), but evidence also suggests that doctor visit anxiety can occur during more routine interactions such as an annual check-up (Street et al. 2009), potentially causing patients to avoid doctors altogether. Given our definition, we assess doctor visit anxiety with a series of feelings/emotions specific to the worry, uncertainty, anxiety, and dread patients feel during doctor/patient consultations.

Reducing doctor visit anxiety is considered a positive and "proximal" psychosocial outcome that may have more long-term effects on other physical and emotional health outcomes such as seeking physician consultations and SWB (Street et al. 2009). Thus, its importance as a potential outcome of health literacy, health numeracy, and trust in doctor cannot be understated, nor can its relevance as a potential antecedent of number of doctor visits and SWB. Doctor visit anxiety is a construct that requires further study (van Osch et al. 2014).

Number of Doctor Visits

The willingness to seek a physician's consultation is a function of many issues, including a variety of demographic factors, health care availability, current physical health, and the health condition for which the consultation is being sought (CDC 2017). Irrespective of the reasons for visiting a doctor, such consultations are viewed as an important component in preventing and curing disease and maintaining one's health (CDC 2017). In this research, we defined and measured the frequency of physician consultations as the self-reported number of doctor visits over the past 2-year period.

Subjective Well-Being

Due to its relationships with positive outcomes across several life domains, subjective emotional/psychological well-being (SWB) has garnered much attention in social and health sciences research (Kansky and Diener 2017). SWB has several definitions, but most include elements of overall high life satisfaction, high positive affect, and low negative affect. Recently, Su, Tay, and Diener (2014) advanced the concept of SWB as "thriving," that encompasses elements of current and future states of emotional health, life satisfaction, self-worth and belonging, having a sense of purpose, accomplishment and belonging, feeling energetic, and being optimistic about the future. To assess this construct, Su, Tay, and Diener (2014) developed the 10-item Brief Inventory of Thriving (BIT) scale, which is the criterion measure we use in this research to assess SWB.

There are two key reasons to examine SWB as a potential outcome of doctor visit anxiety, health literacy, health numeracy, and trust in doctor. First, SWB has been shown to be related to protecting against heart disease and stroke (Rozanski and Kubzansky 2005), living a longer life (Diener and Chan 2011), increased job satisfaction and performance (Judge, Ilies, and Dimotakis 2010), and making wise consumer choices (Gilovich, Kumar, and Jampol 2015). Given such potential outcomes of SWB, focusing on its potential antecedents is equally important (Friedman and Kern 2014).

Second, though some studies have examined dimensions of general negative affect (e.g., depression), we are unaware of any studies examining the potential health literacy, health numeracy, trust in doctor → doctor visit anxiety → SWB chain of effects. As such, our studies treat SWB as a key transformative health-related outcome of increasing importance to the field of health care marketing (Anderson et al. 2016).

THEORETICAL BACKGROUND AND HYPOTHESES

There are several health-related theories that would support the hypotheses we are about to offer, including Protection Motivation Theory (PMT; Rogers and Prentice-Dunn 1997) and the Health Belief Model (HBM; Janz and Becker 1984). However, given that health care systems now expect patients to play a much more active/coproduction role in their health care (Mende et al. 2017), the key need elements of Self Determination Theory (SDT) seem the most theoretically appropriate. Further, as Connor and Norman (2005) note, these SDT elements have extensive overlap with the key tenets of PMT and the HBM.

SDT focuses on how knowledge and social interactions facilitate (or hinder) one's sense of volition to affect well-being (Ryan and Deci 2000). Three SDT psychological needs—autonomy, competence, and relatedness—are believed to impact various dimensions of well-being, and the degree to which any of these needs is supported or thwarted within a social context will have both immediate (doctor visit anxiety) and long-term (number of doctor visits, SWB) effects. Autonomy reflects self-regulated knowledge and actions which enable ownership of goals in a given setting; competence reflects the confidence patients have in their knowledge, ability to participate, and interact with others in goal attainment; and relatedness reflects a sense of being respected and willingness to engage in behaviors and interactions with others to achieve personal benefits and establish cohesion with others. These needs are often unmet in the health care service setting in which patients feel vulnerable (Sharma, Conduit, and Hill 2017).[2]

Health Literacy → Doctor Visit Anxiety

Linear Relationships

Consistent with the SDT needs of autonomy and competence, patients scoring high on functional health literacy will not likely require assistance in completing and understanding health forms and reading health information as they feel confident in their ability to do so without assistance (Nutbeam 2008). Recent research suggests that patients who are competent and confident in their subjective knowledge and understanding of health showed more positive affect toward health care providers (Sharma, Conduit, and Hill 2017). The higher level of autonomy and competence endemic to functional health literacy should be associated with lower doctor visit anxiety (Street et al. 2009; H1).

The SDT need of relatedness reflects a sense of being respected by others and interacting with others to achieve personal benefits and cohesion. A goal of physician–patient consultations is the dissemination of information regarding health concerns in a respectful and clear manner (Roth 1994). When the communication style is open and affiliative, patient distress should be lower (Haskard et al. 2008). Open and affiliative interaction is a hallmark of communicative health literacy, creating shared understanding and cohesion between patient and doctor that lowers situation-specific anxiety (Street et al. 2009). We predict a negative communicative health literacy—doctor visit anxiety relation (van Osch et al. 2014; H2).

Potential Curvilinear (Quadratic) Relationships

As previously noted, consideration of quadratic effects may enable researchers to better understand tipping points among predictors and outcomes, and thus adjust communication efforts to better serve patients. So, a relevant issue is whether dimensions of health literacy have more than linear effects with doctor visit anxiety. Though we offer no formal

2. PMT proposes that people protect themselves based on the perceived severity of a threat (poor health), their vulnerability to the threat, the efficacy of recommended preventive behavior, and their self-efficacy in preventing the threat. The HBM model posits that people's beliefs about health problems, perceived benefits of action, impediments to action, and self-efficacy explain engagement in health-promoting behavior. Thus, it seems evident that elements of PMT and HBM share overlap with SDT but are not identical to the major tenets of SDT.

hypotheses, we explore the potential for curvilinear (quadratic) effects of health literacy.

Functional health literacy reflects the perceived confidence patients have in understanding verbal and written information pertaining to health issues. Information processing research (Eagly and Chaiken 1993) and the competence and autonomy needs of SDT (Ryan and Deci 2000) suggest that individuals at the very highest levels of confidence in their knowledge and ability to process and understand information may show disproportionally stronger effects on affect than those at more moderate levels (i.e., a curvilinear pattern). We thus test for a negative quadratic relationship among functional health literacy and doctor visit anxiety.

For communicative health literacy to be effective, it requires two-way communication in which patients must ask relevant questions of their health care provider, and the provider must ask relevant questions and offer understandable information to patients (Nutbeam 2008). Consistent with the relatedness need of SDT to foster positive outcomes and avoid negative ones (Ryan and Deci 2000), at the very highest level of communicative health literacy, its relationship with doctor visit anxiety may be upward sloping. For example, when patients are extremely motivated to gather and exchange information in a health care setting, the effects on outcomes may be polarized and asymmetric. Thus, we explore the potential for a negative quadratic communicative health literacy → doctor visit anxiety relationship.

Health Numeracy → Doctor Visit Anxiety

On the surface, it may seem intuitive that health numeracy would be associated with lower doctor visit anxiety. Yet, we are unaware of any studies examining the relationship between health numeracy and doctor visit anxiety. In studying concepts of general cognitive and math ability, some find negative relationships with measures related to anxiety. For example, Duckworth et al. (2012) report a negative correlation ($r = -.12$) among general numeracy and negative psychological affect. Others, though, go so far as to suggest that the increased cognitive processing of the highly numerate could result in an anxiety-producing reactance effect (Peters et al. 2006).

What then, is the likely relationship of a health-specific measure of numeracy with a health-specific measure of anxiety? We predict it should be negative. Domain-specific knowledge tends to be a salient predictor of domain-specific affect (Eagly and Chaiken 1993), and the competence need of SDT would suggest that higher health numeracy would be associated with lower doctor visit anxiety. Finally, some researchers suggest that numeracy specific to health issues would have such an effect, and that the effect may extend to positive mental health outcomes as well (Levy et al. 2014). Thus, we expect a negative relationship between health numeracy and doctor visit anxiety (H3).[3]

Trust in Doctor → Doctor Visit Anxiety

Linear Relationship

There are many pathways in which doctors may affect situation-specific and general health outcomes (Street et al. 2009). One such pathway is trust. Akin to the relatedness need of SDT, the trust patients place in their doctors is a function of the information, empathy, and respect patients perceive during patient–doctor consultations, which in turn leads to an enhanced sense of cohesion, resulting in health benefits to the patient (Roth 1994).

Given the vulnerability patients feel in health care settings, the trust they place in their physician can have profound effects on patient outcomes (Seiders et al. 2015). Research suggests that physician trust can temper a patient's anxiety and uncertainty during bad news consultations and routine health visits (Roth 1994; Street et al. 2009). We predict a negative trust in doctor → doctor visit anxiety pathway (H4).

Potential Curvilinear Relationship

There is literature to suggest that at its highest level, trust in doctor could show a negative curvilinear relationship with doctor visit anxiety. In his qualitative study, Roth (1994) found that patient trust in physicians was the most prevalent quality that patients sought in doctors which lowered stress in doctor–patient consultation settings. At the very highest level of patient trust in doctors, doctor visit anxiety may decrease at more than a linear rate (Bachinger, Kolk, and Smets 2009). Further, trust in service providers has been viewed as reflecting a higher-order need consistent with the relatedness need of SDT that may have curvilinear effects on patient affect and behavior. Given the high-involvement/high-vulnerability nature of health care, trust in doctor at the highest level may show incremental increasing returns in lowering doctor visit anxiety: a potential negative quadratic effect.

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3. We could find no theoretical rationale for exploring a health numeracy → doctor visit anxiety quadratic effect. In the study that follows then, we do not report on such an effect. When such an effect was estimated, it was not significant, nor did it alter the significance or magnitude of any other predictor examined.

Doctor Visit Anxiety Effects on Number of Doctor Visits and SWB

Doctor Visit Anxiety → Number of Doctor Visits

Situation-specific anxiety inhibits positive behaviors (Carver and White 1994), and this inhibition may be pronounced in health care settings. When patients anticipate negative affect (e.g., anxiety, worry) toward physician consultations, they are less likely to engage in the consultation process. In essence, patients with greater trust in their physicians have reduced anxiety about physician consultations, and as such, they are likely to consult their physicians more frequently and develop long-term relationships with their physicians (Street et al. 2009). We predict a negative relationship between doctor visit anxiety and number of doctor visits (H5).

Doctor Visit Anxiety → SWB

Though it has been shown that trait-related negative affect (e.g., depression) is related to SWB (Kansky and Diener 2017), we are unaware of any empirical evidence examining a specific doctor visit anxiety → SWB linkage. In the study of mood disorders, theories of cognitive processing suggest that episodic or situation-specific anxiety can have persistent effects on more global assessments of SWB (Berenbaum et al. 1999). Individuals who are unable to regulate anxiety triggered by specific environmental situations are likely to experience overall lower well-being (Cote, Gyurak, and Levenson 2010), which suggests a negative relationship between doctor visit anxiety and SWB (H6).

Incremental Effects on Number of Doctor Visits

Health Literacy → Number of Doctor Visits: Linear Relationships

Recall that functional health literacy is a subjective assessment reflecting the perceived confidence patients have in understanding verbal and written information pertaining to health issues. Though some studies show a positive correlation between subjective knowledge and behaviors in health domains, the "feeling of knowing" may lead patients to perceive few benefits in consulting experts because patients have become overconfident in their own abilities (Wood and Lynch 2002). In fact, a recent study found that only patients low in functional health literacy visited a general practitioner most often (van der Heide et al. 2015), a finding which might suggest that patients higher in functional health literacy would seek fewer consultations with physicians. As such, we predict a negative relationship between functional health literacy and number of doctor visits (H7).

Alternatively, we expect that the incremental effect of communicative health literacy with number of doctor visits will be positive. Consistent with the relatedness need of SDT, communicative health literacy is open and affiliative, lowering doctor visit anxiety in the short term while leading to greater patient participation in health care and potentially more interactions with their physicians in the longer term, i.e., a greater number of doctor visits (Haskard et al. 2008; Haun et al. 2014; H8).

Health Literacy → Number of Doctor Visits: Potential Curvilinear Relationships

As with doctor visit anxiety, we test for potential curvilinear effects of health literacy on number of doctor visits. Again, we put forth no formal hypotheses but suggest that such effects are plausible.

Number of doctor visits is a behavioral outcome, and in-service environments, there is evidence to suggest that curvilinear effects are both evident and important for behavioral outcomes (Agustin and Singh 2005). Given consequences can be profound in the health care setting, the examination of curvilinear effects can potentially offer important insights regarding "tipping points" related to the effects of information and communication efforts on behaviors (Andrews, Netemeyer, and Burton 2009). Since we hypothesize a negative linear functional health literacy → number of doctor visits relationship, we suspect that those at the very highest level of "feeling of knowing" could show an even more pronounced negative curvilinear (quadratic) relationship with number of doctor visits.

In examining a communicative health literacy → number of doctor visits curvilinear relationship, the literature might suggest a positive directionality. The more that communication among physician and patient is open and affiliative, the greater the likelihood that the patient will follow-up with the physician over time (Roth 1994). At its highest level, we test if there is an incremental positive quadratic effect in which a unit change in communicative health literacy has an increasingly stronger positive effect on number of doctor visits.

Health Numeracy → Number of Doctor Visits

How health numeracy may relate to the frequency of physician consultations is also a bit unclear. Studies show that higher health numeracy scores are associated with better understanding of health risks, and it has been suggested that health numeracy could have "down the line" positive effects on health behaviors (Reyna et al. 2009). However, the TOHFLA (Parker et al. 1995), which incorporates a numeracy component, has been shown to be negatively related to utilization of preventive and routine medical services (Scott et al. 2002), and other literature suggests a potential negative relationship between health numeracy and doctor visits. A high level of objective knowledge (numeracy) may lead patients to be overconfident in their abilities, and thus perceive less benefit from expert consultations. Again, this "feeling of knowing" may lead to lower use of professional advice in the form of number of physician consultations (Wood and Lynch 2002). We predict a negative relationship between health numeracy and number of doctor visits (H9).

Trust in Doctor → Number of Doctor Visits: Linear Relationship

There is a wealth of marketing literature showing that trust in one's provider is paramount in maintaining long-term relationships between service provider and customer (Doney and Cannon 1997). In the realm of health care, trust may play an even stronger role given the lack of patient expertise and the profound potential outcomes (Loewenson and Simpson 2017). Patients with greater trust in their doctors are more likely to consult their doctors on numerous occasions over time (Dang et al. 2017). We expect a positive relationship between trust in doctor and number of doctor visits (H10).

Trust in Doctor → Number of Doctor Visits: Potential Curvilinear Relationship

At the highest level of trust in doctor, could its relationship with number of doctor visits be curvilinear? Two qualitative studies and evidence from the services literature add credence to this possibility. Roth (1994) and Dang et al. (2017) found that trust in doctor established early in the patient–doctor relationship was associated with more frequent visits, and at the highest level this relationship may even be more pronounced than at more moderate or high levels (i.e., a curvilinear pattern). Likewise, in a non-health care service context, Agustin and Singh (2005) showed that trust in provider had a positive quadratic effect on loyalty (a behavioral outcome).

Incremental Effects on SWB

Health Literacy → SWB: Linear Relationships

There are two reasons to predict positive health literacy → SWB relationships. First, general literacy has been associated with an array of positive socio-economic and health outcomes that may increase SWB (Angner et al. 2010). As literacy becomes more domain-specific (e.g., health literacy), the linkage is likely to be strengthened as domain-specific subjective knowledge is a stronger predictor of domain-specific outcomes than general knowledge (Eagly and Chaiken 1993; Hader, Sood, and Fox 2013).

Second, health literacy may be viewed as a means for individuals to feel empowered, take greater personal control, and experience a greater sense of security by understanding health issues, health care, and health care providers (Anderson et al. 2016; Batterham et al. 2016). This notion is consistent with the competence and relatedness needs of SDT (Ryan and Deci 2000). When patients are confident that they understand information and feel they are understood and respected by providers in a service context, positive psychological outcomes accrue (Mende and van Doorn 2015). Patient participation in personal health care—endemic to functional and communicative health literacy—should have the ability to improve overall SWB (Anderson et al. 2013; Ostrom et al. 2015). We therefore predict that functional and communicative health literacy are positively related to SWB (H11 and H12).

Health Literacy → SWB: Potential Curvilinear Relationships

We also test if the health literacy → SWB relationships are upward sloping. Consistent with SDT, functional and communicative health literacy may fulfill higher order needs that affect well-being. When these needs are met beyond what is expected (highest levels), their effects on emotional/psychological well-being (SWB) may be disproportionally higher than at levels in which these needs are "just met," reflecting a potential positive quadratic relationship.

Health Numeracy → SWB

The directionality for a direct health numeracy to SWB relationship is somewhat unclear. For example, Judge, Ilies, and Dimotakis (2010) report a positive correlation ($r = .19$), but only an indirect positive effect of general mental ability (akin to general numeracy) on SWB through various socio-economic variables and perceived physical health status. Similarly, Duckworth et al. (2012) report a positive correlation ($r = .16$), but a nonsignificant effect of general cognitive ability (that included a general numeracy component) on life satisfaction. And as noted earlier, others suggest that the increased cognitive processing of the highly numerate could result in a reactance effect, leading them to engage in suboptimal behaviors and decision making, ultimately lowering SWB (Peters et al. 2006).

Still, we predict a positive health numeracy → SWB relationship. Domain-specific knowledge (health) and domain-specific affect (well-being) tend to be positively correlated (Levy et al. 2014). The competence need of SDT would also suggest a positive health numeracy to SWB effect (Ryan and Deci 2000), as competence encompasses the concept of objective knowledge that should enable patients to increase their SWB. Finally, there is some evidence to suggest that numeracy specific to health issues would have such an effect, and that the effect may extend to positive mental health outcomes (Levy et al. 2014). It has been hypothesized that higher health numeracy may increase overall positive affect: a component of SWB (Schapira et al. 2014). We expect a positive health numeracy → SWB relationship (H13).

Trust in Doctor → SWB Linear Relationship

Theoretical models in a health care setting suggest a positive physician trust to emotional well-being effect. In a recent review, Loewenson and Simpson (2017) present a framework positing a physician trust to well-being relationship. In their model of direct and indirect pathways to health outcomes, (Street et al. 2009) show both an indirect effect of clinician trust on patient emotion management in the health care setting (i.e., doctor visit anxiety) and a direct effect of clinician trust on emotional well-being. We predict a direct positive trust in doctor → SWB relationship (H14).

Trust in Doctor → SWB Potential Curvilinear Relationship

Is the relationship potentially curvilinear? As previously stated, trust in doctor is viewed as a prime pathway in lowering doctor visit anxiety (a negative situation-specific affective state), and at its highest level the effect may be curvilinear (Bachinger, Kolk, and Smets 2009). We test if a similar, albeit positive, quadratic effect could be possible for the trust in doctor → SWB relationship.

MAIN STUDY

Procedures and Measures

We used a sample of 4,040 adults from the Qualtrics' online panel who were screened to be nationally representative in terms of age, education, and income, but who were equally split among Caucasians and African Americans.[4]

Functional health literacy was measured with four items scored on 5-point scales (scores could range from 4 to 20; $\alpha = .80$), and

4. We originally suspected that race might moderate the effect of health numeracy on doctor visit anxiety, number of doctor visits, and SWB due to potential health numeracy differences among Caucasians and African Americans. Thus, we restricted our sample just to Caucasians and African Americans. We found that Caucasians scored higher than African Americans on health numeracy (Caucasian: mean = 3.34; African American: mean = 2.20, $F = 279.74$, $p < .01$). In subsequent analyses, though, we found that race did not moderate the effects of health numeracy on any dependent variable.

communicative health literacy was measured with three items scored on 3-point scales (scores ranging from 3 to 9; $\alpha = .76$). Both measures, as well as their 5- and 3-point scale scoring, were based on procedures found in the Bishop et al. (2016), Chinn and McCarthy (2013), and Parker et al. (1995) scales. Health numeracy was assessed with eight items ($\alpha = .76$) drawn primarily from the General Health Numeracy Test-6 (GHNT6; Osborn et al. 2013) and Numeracy in Understanding Medicine Instrument (NUMi; Schapira et al. 2014). We used two MTurk pretests ($n = 100$ and $n = 1{,}618$) to derive our health literacy and health numeracy measures. Appendix A details the procedures and the measures derived.

Trust in doctor was measured with the 5-item patient trust in physician scale (Dugan, Trachtenberg, and Hall 2005). Items were assessed on 5-point strongly disagree to strongly agree scales, then summed and averaged to form a 1 to 5 score ($\alpha = .88$) in response to the following prompt: "The statements below pertain to your primary care physician or the doctor you see most often … " The five items read: "(1) Sometimes your doctor cares more about what is convenient for (him/her) than about your medical needs (reverse-scored); (2) Your doctor is extremely thorough and careful; (3) You completely trust your doctor's decisions about which medical treatments are best for you; (4) Your doctor is totally honest in telling you about all of the different treatment options available for your condition; and (5) All in all, you have complete trust in your doctor."

Doctor visit anxiety was measured with four 7-point strongly disagree to strongly agree items summed and averaged in response to the statement: "Below is a list of feelings/emotions you might have when consulting your physician. Please think about each emotion carefully and whether a physician health examination made you feel..." The emotions listed were: *uneasy*, *worried*, *anxious*, *dread* ($\alpha = .90$). Frequency of physician consultations (number of doctor visits) was a self-report measure: "In the past two years, on how many occasions did you consult your primary care doctor or a doctor you see most often?" (coded as six categories: 1–2 times, 3–4 times, 5–6 times, 7–8 times, 9–10 times, 11 or more times). SWB was assessed with the 10-item BIT scale (Su, Tay, and Diener 2014). We summed and averaged the 5-point items to form a 1 = poor to 5 = excellent SWB score ($\alpha = .93$).

Control Variable Measures

Prior research has shown that several socio-economic variables are related to the focal constructs shown in Figure 1, which if not controlled for could bias parameter estimates among these focal constructs (Judge, Ilies, and Dimotakis 2010). We gathered measures of gender (0 = female: 76%;

1 = male: 24%), age, race/ethnicity, income, and education. We coded age into three categories: Millennial (18–34: 35%); Gen X (35–50; 25%); and Baby Boomer or Older (51–70; 40%). Race was coded as "0" (African American; 50%) and "1" (Caucasian; 50%) dummy variable. We originally assessed six categories of income ranging from "$20K per year or less" to "$90K per year or more." We coded these into three categories: less than $35K (44.9%); $35K to $75K (36.2%); more than $75K (18.9%). We assessed seven education categories ranging from "8th grade or less" to "MS, PhD, Law, Doctor." We ultimately coded these into two categories for our analyses: 1 = 4-year college degree or more (42.8%) and 0 = less than a 4-year college degree (57.2%).

Finally, perceived current physical health has been shown related to measures of anxiety, number of doctor visits, and SWB (Judge, Ilies, and Dimotakis 2010). We assessed perceived current physical health with a single 5-point scale: "How would you rate your current physical health?" (1 = poor; 5 = excellent). Table 1 shows summary statistics and correlations.

Analyses and Results

We estimated a series of hierarchical regression models for each dependent variable, as we wanted to demonstrate the predictive validity of our hypothesized predictors relative to control variables. We first mean-centered and then squared functional and communicative health literacy and trust in doctors to create their curvilinear (quadratic) terms (Cohen et al. 2003).

Doctor Visit Anxiety

Table 2 shows the results for doctor visit anxiety. In the first model ($F = 53.04$, $p < .01$, $R^2 = .095$) we found significant effects for gender ($\beta = -.19$, $t = 3.37$, $p < .01$) and race ($\beta = .25$, $t = 4.73$, $p < .01$). Females reported greater doctor visit anxiety than males, and Caucasians reported greater doctor visit anxiety than African Americans. Both the Millennial ($\beta = .78$, $t = 13.02$, $p < .01$) and Gen X age groups ($\beta = .54$, $t = 8.60$, $p < .01$) reported greater doctor visit anxiety than their Baby Boomer counterparts. Current perceived physical health showed the expected negative coefficient ($\beta = -.39$, $t = 14.80$, $p < .01$).

In the second model ($F_{change} = 143.70$, $p < .01$, $R^2 = .208$), we found the predicted negative relations for functional health literacy (H1: $\beta = -.11$, $t = 14.30$, $p < .01$), communicative health literacy (H2: $\beta = -.06$, $t = 2.94$,

TABLE 1
Summary Statistics and Correlations

	Mean	Standard Deviation	Functional Health Literacy	Communicative Health Literacy	Health Numeracy	Trust in Doctor	Doctor Visit Anxiety	Number of Doctor Visits	SWB
Functional health literacy	16.99	3.38	1.00						
Communicative health literacy	8.01	1.32	.26	1.00					
Health numeracy	2.77	2.24	.21	.09	1.00				
Trust in doctor	3.67	.86	.14	.26	−.01	1.00			
Doctor visit anxiety	3.36	1.62	−.30	−.20	−.08	−.31	1.00		
Number of doctor visits	2.70	3.10	−.05	.09	−.06	.16	−.06	1.00	
SWB	3.74	.82	.15	.21	−.03	.29	−.33	−.04	1.00
Age	44.30	16.28	.22	.22	.10	.17	−.19	.18	.09
Gender	.24	.43	−.07	−.04	.15	.04	−.07	.01	.02
Race	.50	.50	.04	.02	.25	.01	.02	.04	−.05
Income	2.95	1.60	.06	.04	.21	.06	−.10	−.06	.21
Education	4.42	1.24	.11	.07	.29	.02	−.08	−.06	.14
Current physical health status	3.17	.96	.12	.09	.06	.13	−.22	−.21	.45

In general, correlations greater than .06 in absolute magnitude are significant ($p < .05$). Gender (0 = female; 1 = male); race (0 = African American; 1 = Caucasian); income (originally 6 categories ranging from 1 = "$20K or less" to 6 = "$90K or more"); education (originally 7 categories ranging from 1 = "8th grade or less" to 6 = "graduate/professional degree").

TABLE 2
Regression Results: Doctor Visit Anxiety

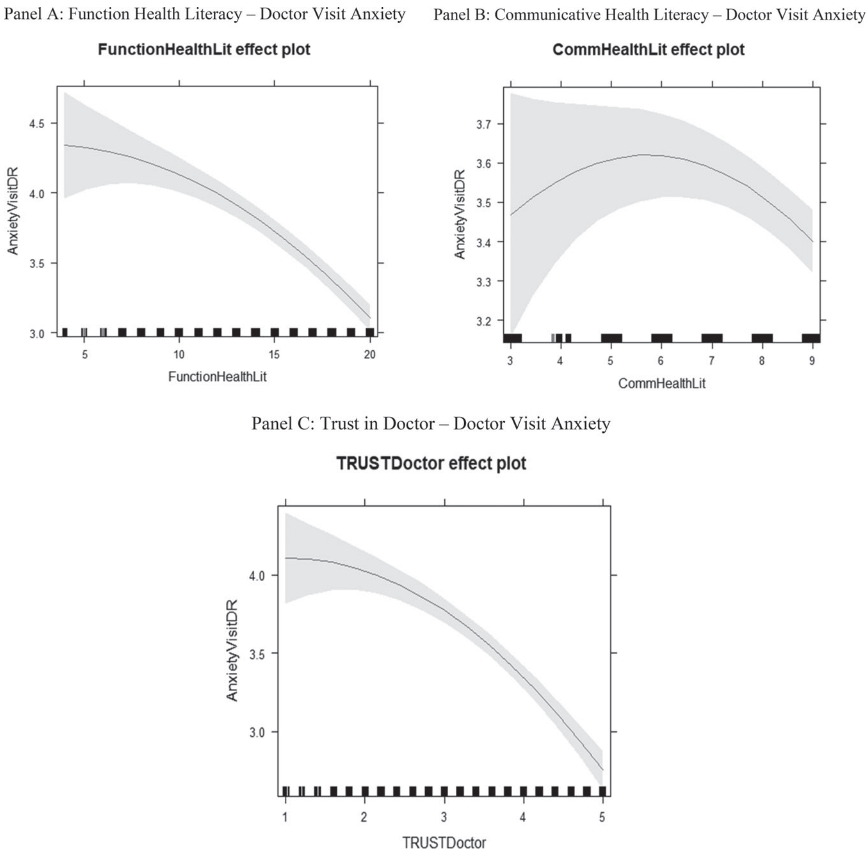
	Model 1: Doctor Visit Anxiety	Model 2: Doctor Visit Anxiety	Model 3: Doctor Visit Anxiety
Control variables			
Gender (0 = female; 1 = male)	−.19 (−.05)**	−.25 (−.07)**	−.25 (−.07)**
Race (0 = African American; 1 = Caucasian)	.25 (.08)**	.18 (.06)**	.19 (.06)**
Age: Millennial	.78 (.23)**	.41 (.12)**	.38 (.11)**
Age: Gen X	.54 (.14)**	.31 (.08)**	.30 (.08)**
Income: less than \$35K	.08 (.03)	.04 (.01)	.06 (.02)
Income: \$35K to \$75K	−.02 (−.01)	−.02 (−.01)	−.02 (−.01)
Education (0 = HS graduate or less; 1 = college degree)	−.04 (−.01)	−.01 (−.01)	−.01 (−.01)
Current physical health status	−.39 (−.23)**	−.28 (−.16)**	−.27 (−.16)**
Hypothesized predictors			
H1: Functional health literacy		−.11 (−.22)**	−.12 (−.25)**
H2: Communicative health literacy		−.06 (−.05)**	−.10 (−.09)**
H3: Health numeracy		−.01 (−.02)	−.01 (−.02)
H4: Trust in doctor		−.43 (−.23)**	−.45 (−.24)**
Potential quadratic effects			
Functional health literacy			−.01 (−.05)*
Communicative health literacy			−.02 (−.05)*
Trust in doctor			−.09 (−.06)**
R^2	.095	.208	.214

Values are unstandardized β coefficients with standardized β coefficients in parentheses. Baby Boomers was used as the reference category for age; greater than \$75K was used as the reference category for income.
*$p < .05$.
**$p < .01$.

$p < .01$), and trust in doctor (H4: $\beta = -.43$, $t = 15.25$, $p < .01$). Health numeracy was not significant (H3: $\beta = -.01$, $t = 1.08$, $p = .28$).

The third model added the potential quadratic effects ($F_{\text{change}} = 8.68$, $p < .01$, $R^2 = .214$), and all were significant and negative: functional health literacy ($\beta = -.01$, $t = 2.48$, $p < .05$); communicative health literacy ($\beta = -.02$, $t = 2.05$, $p < .05$); and trust in doctor ($\beta = -.09$, $t = 3.77$, $p < .01$). Using the Cohen et al. (2003, 205–207) procedure for plotting quadratic effects with control variables, Panels A, B, and C of Figure 2 show plots of these effects. For functional health literacy (Panel A) the downward sloping effect begins at a value of 4.80 and continues curving downward where at a value of 19, predicted doctor visit anxiety is 3.23. Panel B shows a more pronounced effect for communicative health literacy. The downward curvilinear effect occurs at a communicative health

FIGURE 2
Curvilinear (Quadratic) Effects with Doctor Visit Anxiety. Panel A: Function Health Literacy—Doctor Visit Anxiety. Panel B: Communicative Health Literacy—Doctor Visit Anxiety. Panel C: Trust in Doctor—Doctor Visit Anxiety.



literacy score of 5.71; at the maximum communicative health literacy value of 9, predicted doctor visit anxiety is 3.39. Panel C shows the plot for trust in doctor. The curvilinear effect begins at a value of 1.21 and continues sloping until at the maximum trust in doctor value of 5, at which point the predicted doctor visit anxiety is 2.42.

Number of Doctor Visits

As shown in Table 3, in the first model ($F = 41.14$, $p < .01$, $R^2 = .075$), the Millennial ($\beta = -.57$, $t = 10.16$, $p < .01$) and Gen X age groups ($\beta = -.42$, $t = 7.03$, $p < .01$) reported fewer doctor visits than Baby Boomers. Respondents in the lower-income groups (less than $35K:

TABLE 3
Regression Results: Number of Doctor Visits

	Model 1: Number of Doctor Visits	Model 2: Number of Doctor Visits	Model 3: Number of Doctor Visits	Model 4: Number of Doctor Visits
Control variables				
Gender (0 = female; 1 = male)	.06 (.02)	.04 (.01)	.05 (.01)	.06 (.02)
Race (0 = African American; 1 = Caucasian)	−.03 (−.01)	−.01 (−.01)	.05 (.02)	.05 (.02)
Age: Millennial	−.57 (−.18)**	−.51 (−.16)**	−.45 (−.14)**	−.44 (−.14)**
Age: Gen X	−.42 (−.12)**	−.37 (−.11)**	−.32 (−.09)**	−.31 (−.09)**
Income: less than $35K	.18 (.06)**	.18 (.06)**	.17 (.05)**	.14 (.05)*
Income: $35K to $75K	.12 (.04)	.12 (.04)	.11 (.03)	.10 (.03)
Education (0 = HS graduate or less; 1 = college degree)	−.02 (−.01)	−.02 (−.01)	.02 (.01)	.02 (.01)
Current physical health assessment	−.30 (−.19)**	−.34 (−.21)**	−.35 (−.22)**	−.35 (−.22)**
Hypothesized predictors				
H5: Doctor visit anxiety		−.08 (−.09)**	−.06 (−.07)**	−.06 (−.07)**
H7: Functional health literacy			−.04 (−.08)**	−.04 (−.08)**
H8: Communicative health literacy			.07 (.06)**	.02 (.01)
H9: Health numeracy			−.04 (−.05)**	−.04 (−.05)**
H10: Trust in doctor			.24 (.14)**	.29 (.16)**
Potential quadratic effects				
Functional health literacy				.00 (.00)
Communicative health literacy				−.02 (−.05)*
Trust in doctor				.10 (.07)**
R^2	.075	.083	.113	.119

Values are unstandardized β coefficients with standardized β coefficients in parentheses. Baby Boomers was used as the reference category for age; greater than $75K was used as the reference category for income.
*$p < .05$.
**$p < .01$.

$\beta = .18$, $t = 2.81$, $p < .01$ and $35K to $75K: $\beta = .12$, $t = 1.87$, $p = .06$ [marginally significant]) reported more doctor visits than those in the highest income group (greater than $75K). Better perceived current physical health was associated with fewer doctor visits ($\beta = -.30$, $t = 12.34$, $p < .01$).

In the second model ($F_{change} = 32.45$, $p < .01$, $R^2 = .083$), doctor visit anxiety showed the predicted negative relationship (H5: $\beta = -.08$, $t = 5.70$, $p < .01$). The third model ($F_{change} = 34.25$, $p < .01$, $R^2 = .113$) showed the predicted negative incremental effects for functional health literacy (H7: $\beta = -.04$, $t = 4.71$, $p < .01$) and health numeracy (H9: $\beta = -.04$, $t = 3.10$, $p < .01$), and the predicted positive incremental effects for communicative health literacy (H8: $\beta = .07$, $t = 3.71$, $p < .01$) and trust in doctor (H10: $\beta = .24$, $t = 8.53$, $p < .01$).

The fourth model ($F_{\text{change}} = 7.97$, $p < .01$, $R^2 = .119$) added the potential quadratic effects. Interestingly, the effect for communicative health literacy was negative ($\beta = -.02$, $t = 2.11$, $p < .05$), and the trust in doctor effect was positive ($\beta = .10$, $t = 4.41$, $p < .01$). Panels A and B of Figure 3 plots these effects. Consistent with its linear relationship, the effect of communicative heath literacy remains positive until it is near its highest level (8.57), after which point the predicted number of doctor visits flattens out. The trust in doctor plot (Panel B) reveals a more pronounced quadratic relationship. At a trust in doctor value of 2.45, predicted number of visits is 2.51, after which the effect then accelerates upward such that when trust in doctor reaches the maximum value of 5, predicted number of doctor visits is 3.21.

Testing Mediation

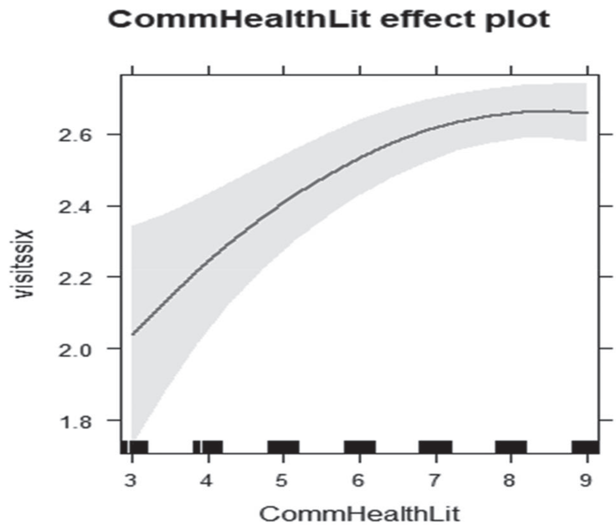
The results above suggest only potential partial mediation of the effects of health literacy, health numeracy, trust in doctor, and some of their quadratic effects on number of doctor visits via doctor visit anxiety. We used Hayes (2018) PROCESS Model 4 to test mediation. With the PROCESS Model 4, each independent variable (with control variables in the model) is tested for direct and indirect effects on number of doctor visits via doctor visit anxiety. Confidence intervals from 5,000 bootstrap samples are generated to assess mediation via indirect effects of the independent variables on the outcome variable. If the confidence intervals do not contain a value of zero, significant mediation is evident (Hayes 2018). We conducted two sets of analyses: one for the linear relationships (Model 3 in Table 3); and one for the quadratic relationships (Model 4 in Table 3).

For the linear effects, these analyses revealed that the confidence intervals did not contain a value of zero for functional health literacy: $\beta = .0066$ [95% CI = .0032 to .0103]; communicative health literacy: $\beta = .0035$ [95% CI = .0008 to .0070]; and trust in doctor: $\beta = .0269$ [95% CI = .0135 to .0408], suggesting their effects were partially mediated. The confidence interval for health numeracy did contain a value of zero, suggesting its effect was neither fully nor partially mediated.

The confidence intervals did not contain a value of zero for the communicative health literacy quadratic effect, $\beta = .0012$ [95% CI = .0001 to .0029], or for the trust in doctor quadratic effect, $\beta = .0052$ [95% CI = .0016 to .0099], suggesting these effects were partially mediated by doctor visit anxiety.

FIGURE 3
Curvilinear (Quadratic) Effects with Number of Doctor Visits. Panel A: Communicative Health Literacy—Number of Doctor Visits. Panel B: Trust in Doctor—Number of Doctor Visits.

Panel A: Communicative Health Literacy – Number of Doctor Visits



Panel B: Trust in Doctor – Number of Doctor Visits

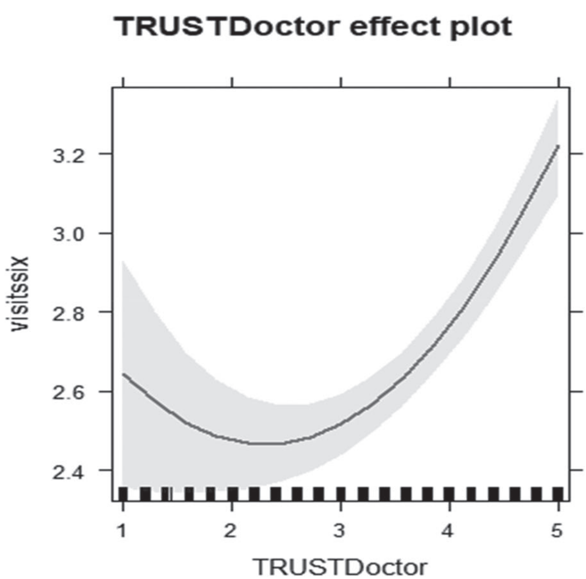


TABLE 4
Regression Results: Subjective Well-Being (SWB)

	Model 1: SWB	Model 2: SWB	Model 3: SWB	Model 4: SWB
Control variables				
Gender (0 = female; 1 = male)	−.01 (−.01)	−.02 (−.01)	.01 (.01)	.001 (.01)
Race (0 = African American; 1 = Caucasian)	−.17 (−.11)**	−.14 (−.09)**	−.09 (−.06)**	−.10 (−.06)**
Age: Millennial	−.24 (−.14)**	−.15 (−.09)**	−.07 (−.04)*	−.06 (−.03)*
Age: Gen X	−.17 (−.09)**	−.11 (−.06)**	−.06 (−.03)*	−.06 (−.03)*
Income: less than $35K	−.15 (−.09)**	−.14 (−.09)**	−.16 (−.10)**	−.16 (−.10)**
Income: $35K to $75K	−.06 (−.04)	−.06 (−.04)	−.07 (−.04)*	−.07 (−.04)*
Education (0 = HS graduate or less; 1 = college degree)	.06 (.03)**	.06 (.04)*	.09 (.06)**	.09 (.06)**
Current physical health assessment	.37 (.44)**	.33 (.39)**	.31 (.37)**	.31 (.36)**
Hypothesized predictors				
H6: Doctor visit anxiety		−.11 (−.22)**	−.09 (−.17)**	−.08 (−.17)**
H11: Functional health literacy			.00 (.01)	.01 (.06)**
H12: Communicative health literacy			.06 (.10)**	.11 (.17)**
H13: Health numeracy			−.03 (−.09)**	−.03 (−.08)**
H14: Trust in doctor			.14 (.15)**	.14 (.15)**
Potential quadratics				
Functional health literacy				.01 (.08)**
Communicative health literacy				.02 (.10)**
Trust in doctor				.01 (.02)
R^2	.231	.276	.316	.323

Values are unstandardized β coefficients with standardized β coefficients in parentheses. Baby Boomers was used as the reference category for age; greater than $75K was used as the reference category for income.
*$p < .05$.
**$p < .01$.

Subjective Well-Being

Table 4 shows the results for SWB. In the first model ($F = 151.78$, $p < .01$, $R^2 = .231$) we found significant effects for race ($\beta = -.17$, $t = 7.12$, $p < .01$), education ($\beta = .06$, $t = 2.76$, $p < .01$), Millennial ($\beta = -.24$, $t = 8.51$, $p < .01$) and Gen X ($\beta = -.17$, $t = 5.87$, $p < .01$) age groups, and the income categories of less than $35K ($\beta = -.15$, $t = 4.95$, $p < .01$) and $35K to $75K ($\beta = -.06$, $t = 1.90$, $p = .06$ [marginally significant]). Current perceived physical health was positively associated with SWB ($\beta = .37$, $t = 30.91$, $p < .01$).

The second model ($F_{change} = 250.42$, $p < .01$, $R^2 = .276$) shows the predicted negative relationship for doctor visit anxiety (H6: $\beta = -.11$, $t = 15.82$, $p < .01$). Model 3 ($F_{change} = 57.96$, $p < .01$, $R^2 = .316$) shows that communicative health literacy (H12: $\beta = .06$, $t = 6.86$, $p < .01$) and trust in doctor (H14: $\beta = .14$, $t = 10.34$, $p < .01$) had positive incremental effects. Functional health literacy was not significant (H11: $\beta = .00$, $t = .72$, $p = .47$), and contrary to what was hypothesized, health numeracy showed a negative relationship (H13: $\beta = -.03$, $t = 5.96$, $p < .01$).

The fourth model ($F_{change} = 14.88$, $p < .01$, $R^2 = .323$) showed that two of three tested quadratic effects were significant: functional health literacy ($\beta = .01$, $t = 4.26$, $p < .01$); and communicative health literacy ($\beta = .02$, $t = 4.56$, $p < .01$). Panels A and B of Figure 4 show these plots. At a functional health literacy value of 14.61, SWB is at its predicted lowest value (3.63); the effect of functional health literacy then slopes upward in a curvilinear fashion where at a value of 20, predicted SWB is 3.73. Panel B shows that at a communicative health literacy value of 5.60, predicted SWB is at a low point (3.53); the effect then slopes upward (i.e., a curvilinear effect) until the maximum value of 9 for communicative health literacy, at which point the predicted value of SWB is 3.77.

Testing Mediation

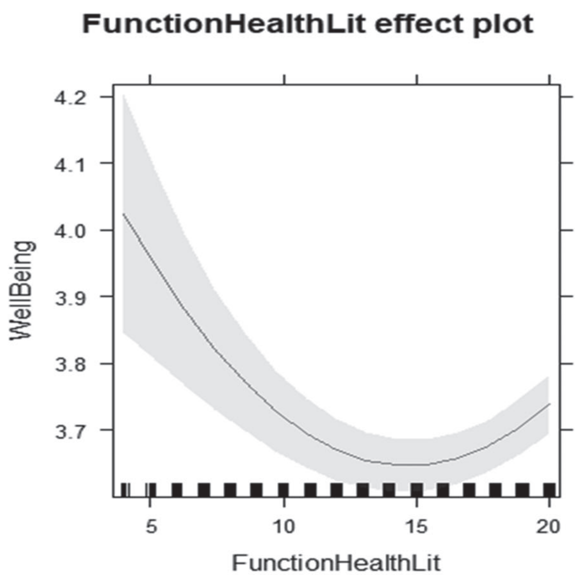
The above results suggest only partial mediation of the linear effects of communicative health literacy, health numeracy, and trust in doctor via doctor visit anxiety, and potential full mediation of functional health literacy. The above results also suggest partial mediation for the quadratic relations of the health literacy dimensions, and potential full mediation for the trust in doctor quadratic effect.

Using Model 3 of Table 4, PROCESS Model 4 revealed that the confidence intervals did not contain a value of zero for functional health literacy: $\beta = .0090$ [95% CI = .0069 to .0114]; communicative health literacy: $\beta = .0047$ [95% CI = .0014 to .0084]; and trust in doctor: $\beta = .0368$ [95% CI = .0293 to .0455]. This suggests that the linear effect of functional health literacy was fully mediated and the linear effects of communicative health literacy and trust in doctor were partially mediated. The confidence interval for health numeracy did contain a value of zero, suggesting its effect was neither fully nor partially mediated.[5]

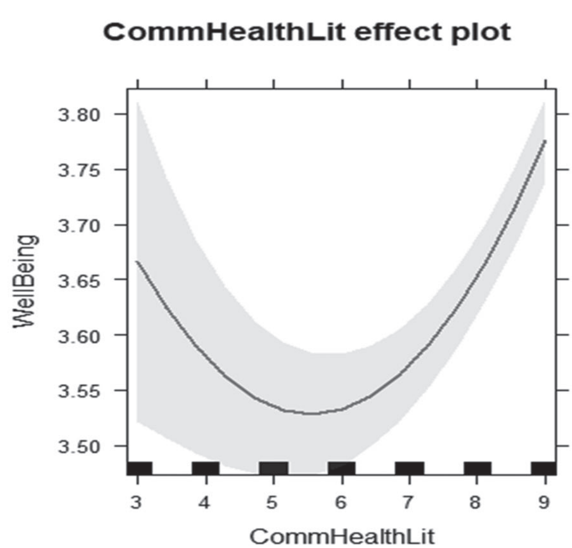
5. A note on the fully mediated health literacy → SWB effect: in Model 3 (Table 4), the functional health literacy → SWB path was not significant. However, the functional health literacy → doctor visit anxiety path was significant (Table 2). Further, when we estimated a functional health literacy → SWB path without a doctor visit anxiety → SWB, the functional health literacy → SWB path was significant. Given that the functional health literacy → SWB path was not significant in Model 3, the finding that it was significant in estimating a model without a doctor visit anxiety → SWB path, and the significant functional health literacy → doctor visit anxiety path, collectively suggests full mediation of the effect functional health literacy on SWB.

FIGURE 4
Curvilinear (Quadratic) Effects with SWB. Panel A: Functional Health Literacy—SWB. Panel B: Communicative Health Literacy—SWB.

Panel A: Functional Health Literacy – SWB



Panel B: Communicative Health Literacy – SWB



For the quadratic effects of Model 4 in Table 4, the confidence intervals did not contain a value of zero for functional health literacy: $\beta = .0003$ [95% CI = .0001 to .0007]; communicative health literacy: $\beta = .0017$ [95% CI = .0001 to .0036]; and trust in doctor: $\beta = .0072$ [95% CI = .0030 to .0117]. This suggests that the functional and communicative health literacy quadratic effects were partially mediated, and the trust in doctor quadratic effect was fully mediated by doctor visit anxiety.

SUMMARY, IMPLICATIONS, AND LIMITATIONS

Summary

Functional and communicative health literacy and trust in doctor were negatively related to doctor visit anxiety in both linear and curvilinear fashions, but health numeracy showed no effect. Doctor visit anxiety was negatively related to the number of doctor visits, and as shown in Model 3 of Table 3, all predicted incremental direct effects were found: functional health literacy and health numeracy were negatively related to number of doctor visits; and communicative health literacy and trust in doctor were positively related to number of doctor visits. Further, two quadratic relationships were found: the communicative health literacy → number of doctor visits quadratic relationship was negative, and the trust in doctor → number of doctor visits quadratic relationship was positive. The direct effects of functional health literacy, communicative health literacy, and trust in doctor were partially mediated by doctor visit anxiety. Health numeracy was neither fully nor partially mediated by doctor visit anxiety.

For SWB, doctor visit anxiety showed the predicted negative relationship, and communicative health literacy and trust in doctor showed the incremental positive relationships. Health numeracy was *negatively* related (and nonmediated) to SWB. Both functional and communicative health literacy showed positive quadratic relationships with SWB. Finally, both the linear and quadratic effects of functional and communicative health literacy and trust in doctor were either fully or partially mediated by doctor visit anxiety.

Implications

The negative health effects of low health literacy and low health numeracy are well known. Those with lower scores on these concepts show a lower adherence to health protocols from physicians, inaccurate assessments of disease risks, and poorer physical health in general. Further, the economic costs associated with low health literacy and numeracy have been estimated to be between $106 and $238 billion annually in the United

States. So, what about health literacy, health numeracy, and trust in doctor *potentially* having *positive effects* (e.g., lowering doctor visit anxiety, increasing the frequency of physician consultations, and enhancing emotional/psychological SWB)? We found some supportive results, but also some mixed results.

Communicative Health Literacy

It has been estimated that the cost of poor doctor–patient communication could be as high as $12 billion annually in the United States (Center for Health Information and Decision Systems 2009). Combined with our communicative health literacy results (potentially lowering doctor visit anxiety, stimulating doctor visits, and enhancing SWB), the importance of clear communication during the patient–health care provider interaction cannot be overstated. In particular, the quadratic effects are intriguing: the plots in Panel B of Figures 2 and 4 show pronounced curvilinear relationships in which "tipping points" are evident. These results collectively suggest that once communicative health literacy scores approach/exceed an approximate value of 6 on a 9-point scale, doctor visit anxiety lowers dramatically and SWB increases dramatically. Though the communicative health literacy → number of doctor visits quadratic was negative, it was not pronounced (Panel A of Figure 3) and only shows a slight downward trend at a very high level (8.57 on a 9-point scale). Its linear relationship with number of doctor visits is much stronger and positive up until that point.

In summary, communicative health literacy is essential, and it must go both ways, i.e., doctor to patient and patient to doctor, further speaking to the idea of coproduction in health care (Mende et al. 2017). Health care providers must be trained to communicate with patients in an understandable manner, engendering empathy and trust in the relationship (Batterham et al. 2016). Likewise, patients must be trained and empowered to ask relevant questions and must participate in the core offering of health care services (Anderson et al. 2016).

How might such training be done? From the health care provider side, recent evidence points to some "best practices" via evidence-based approaches in experimental or randomized control settings. For example, in a randomized control trial with 42 senior and resident physicians over a 5-month period, half of the physicians were exposed to videos and role-playing scenarios stressing theory and practice, simulated patient interviews, and informatory feedback with patients, i.e., the intervention. The other half, the control group, was not. The intervention focused on two methods that had shown some success in the past: (1) the **NURSE** approach, stressing **N**aming, **U**nderstanding, **R**especting, **S**upporting, and

Exploring to foster empathetic verbal skills when communicating with patients and (2) the **WEMS** technique, focusing on **W**aiting, **E**choing, **M**irroring, and **S**ummarizing to encourage an active narrative between doctor and patient. The results showed greater patient-centeredness among doctors and greater patient trust of doctors in the intervention group (Maatouk-Burman et al. 2016).

From the patient side, intervention studies using randomized control or quasi-experimental designs also show promise. A recent review suggests that materials training (workbook or leaflets), multimedia training (videos, web, or computer-based platforms), audio CDs, and personal digital assistants increased patient's active participation in their health care, leading patients to ask more questions concerning their prognosis and treatment options during the doctor–patient interaction (D'Agostino et al. 2017).

Functional Health Literacy

As per functional health literacy, it may be a bit of a "double-edged sword." Functional health literacy showed negative linear and quadratic relationships with doctor visit anxiety, reflecting its ability to potentially influence a *positive* situation-specific psychological outcome. Functional health literacy showed a positive curvilinear relationship with SWB, reflecting its ability to potentially influence a *positive* overall psychological outcome. We feel this latter effect is important. Panel A of Figure 4 reveals a potential tipping point at a functional health literacy value of 14.31 (on a scale of 20). Thus, in affecting overall emotional/psychological well-being, only those at the highest level of functional health literacy may benefit.

That stated, functional health literacy showed the predicted negative relationship with number of doctor visits: a *potential* negative behavioral outcome. As noted by several consumer researchers, high subjective knowledge may lead individuals to be overconfident in what they think they know and see less benefit in consultations with professionals (Wood and Lynch 2002). In our view this speaks to health-system communication programs and policies that constantly remind patients that irrespective of what they think they know, regular physician consultations are still a must (Loewenson and Simpson 2017).

In summary, our study suggests that even though those patients at the very highest level of functional health literacy may feel psychological well-being (SWB), they may be shorting a behavior that could affect their physical well-being (visiting a doctor).

Health Numeracy

Our health numeracy findings were quite mixed: it had no effect on doctor visit anxiety, a negative effect on number of doctor visits, and a negative effect on SWB. Thus, all of the potential health numeracy relationships were null, or more importantly, negative. We expected the negative health numeracy → number of doctor visits linkage, and this effect is consistent with overconfidence in what one knows leading to a perceived lower benefit from expert consultations. The negative direct health numeracy → SWB linkage is troubling. Though the magnitude of this relationship was not strong, it still is contrary to what we predicted. Some possible explanations are as follows.

Is ignorance bliss? One study showed that the less people objectively knew about a complex issue, the less likely they were motivated to become informed due to potentially learning a negative outcome that might affect their well-being (Shepherd and Kay 2012). And as noted by some, the increased cognitive processing of the highly numerate could result in an anxiety producing reactance effect, lowering SWB (Peters et al. 2006).

Another possibility is that individuals with greater health numeracy report lower SWB because they have experienced health-related issues in the past which led them to become more health numerate. Results from the Adult Literacy and Life Skills Survey provide some evidence for such an explanation (Desjardins et al. 2005). Healthier individuals in general had higher numeracy scores than those who were in "poor health," as expected. However, individuals who were classified as being in "excellent health" were found to have lower levels of numeracy as opposed to individuals classified as being in "good health."

What seems more likely though is that objective health knowledge is not as important in raising overall SWB as trust in one's doctor and health literacy. So, is a higher level of health numeracy actually detrimental to SWB? One study (this study) does not sufficiently answer this question. What we are suggesting though is that focusing on basic math-related principals for patients in the domain of health care may require further scrutiny. It is being increasingly shown that objective content knowledge may quickly decay in memory, diminishing its effects on positive affective states and behavior (Fernandes, Lynch, and Netemeyer. 2014). Thus, from a policy perspective, our results point to focusing on improving functional and communicative health literacy rather than improving health numeracy.

Trust in Doctor

Though intuitive, all linear effects of trust in doctor were positive: it was associated with lower doctor visit anxiety, more frequent doctor visits, and higher SWB. What may be of more interest are the quadratic relationships, particularly the trust in doctor → number of doctor visits plot shown in Panel B of Figure 3. A tipping point is evident at a trust in doctor level of 2.45 (on a scale of 5). The number of doctor visits over a 2-year period rises in a curvilinear fashion from that point onward: patients that trust the most (i.e., at the very highest levels) show disproportionately more visits than those patients at more moderate levels of trust.

The implications are simple and clear. In the realm of health care, patient trust in physicians is essential. Given the vulnerability patients feel in health care settings, their reliance on the trust they place in their physician has profound effects on patient outcomes (Seiders et al. 2015). Can doctors be trained to engender patient trust? As noted above, the answer is "yes" (Maatouk-Burman et al. 2016), but care must be taken such that doctors are not stressed. When doctors are stressed their ability to engender patient trust is diminished (Haskard et al. 2008), causing further anxiety during the patient–physician consultation. This further speaks to the coproduction aspect of health care: both physician and patient must be trained to effectively communicate such that they trust each other for maximal benefits to both parties (Anderson et al. 2016; Mende and van Doorn 2015).

Limitations and Future Research

Our study has limitations that open up avenues for future research. First, ours is just one study with cross-sectional correlational data, precluding any causal inferences. Experimental studies are needed to confirm (or possibly refute) our findings. Most notably, what is an optimal combination of types of interventions (e.g., role playing, videos, multimedia, and the use of newer technology like social media, etc.) designed to improve the communication skills of both doctors and patients (D'Agostino et al. 2017)? Experimental research to uncover an optimal combination is needed. Further, and similarly, how can written materials disseminated by health care practitioners be presented in a manner that enhances patient self-efficacy and understanding? Though focused on communicative health literacy, the findings of D'Agostino et al. (2017) suggest that as written materials become clearer and more easily understood, patient's active participation in their health care increases.

Second, though we used numerous controls (demographics and perceived current physical health), there are many other variables related to our outcome variables that we have not accounted for. Studies examining the effects of certain traits, e.g., propensity to plan, self-efficacy and confidence in decision making, need for cognition, etc., have shown that scores on these traits may predict or moderate health and SWB outcomes (Netemeyer et al. 2018). Some of these traits are malleable and can be trained, which means they may represent pathways to better health care. Examining the effects of these traits is an avenue in need of future research.

Finally, we took care to develop psychometrically sound measures of health literacy and health numeracy derived from existing measures. It must still be noted that there is an array of other measures of these constructs that might produce different results. A primary goal of our measure development was brevity and simplicity, given that many existing measures are time-consuming and cumbersome to complete (Haun et al. 2014; O'Neill et al. 2014). It would be worthwhile for researchers to examine the linkages of doctor visit anxiety, frequency of physician consultations, and SWB with other measures of health literacy and health numeracy.

APPENDIX

Deriving Measures of Health Literacy and Health Numeracy

Though several measures of health literacy and health numeracy exist, many of them are confusing to patients, time-consuming to complete (some take over an hour), mix literacy and numeracy items, and lack validity testing (Haun et al. 2014; O'Neill et al. 2014). As such, we use data from two pretests (Pretest One MTurk, $n = 100$ and Pretest Two MTurk, $n = 1{,}618$) to derive brief measures of functional and communicative health literacy and health numeracy.

Functional and Communicative Health Literacy. We culled or adapted items from existing measures of health literacy (Bishop et al. 2016; Chinn and McCarthy 2013; Parker et al. 1995). These items were chosen based on our conceptual definitions of these constructs and because they were judged by the authors to possess face and content validity to these definitions (DeVellis 2012). Further, we kept the scoring procedures for the items in the form in which they were originally published: functional health literacy items on 1 to 5 scales; and communicative health literacy items on 1 to 3 scales. Via a series of principal components factor analyses and item analyses we derived our health literacy measures (Nunnally and Bernstein 1994; Netemeyer, Bearden, and Sharma 2003). We anticipated two factors consistent with the functional and communicative dimensions of health literacy.

Pretest One. With the first principal components analysis, we retained items with loadings above .50 on their hypothesized factor and deleted items with cross-loadings greater than .40. This resulted in retaining four items for functional health literacy and three items for communicative health literacy. With these seven items a second principal component analysis was conducted. These analyses produced two eigenvalues greater than 1 (3.50 and 1.32) that explained 68.58% of the variance in the data. Factor loadings for the four functional health literacy items ranged from .70 to .88; item-to-total correlations ranged from .58 to .80; scale coefficient $\alpha = .85$. Factor loadings for the three communicative items ranged from .62 to .89; item-to-total correlations ranged from .48 to .60; scale coefficient $\alpha = .73$. The correlation among the two scales was $r = .40$.

Pretest Two. With the seven retained items from the first pretest, Pretest Two produced similar results. Principal component analysis produced two eigenvalues greater than 1 (2.95 and 1.53) that explained 64.01% of the variance in the data. Factor loadings for the four functional health literacy items ranged from .67 to .87; item-to-total correlations ranged from .54 to .74; scale coefficient $\alpha = .82$. Factor loadings for the three communicative items ranged from .70 to .83; item-to-total correlations ranged from .43 to .56; scale coefficient $\alpha = .70$. The correlation among the two scales was $r = .29$.

Main Study. We carried these items forward to the main study. Two clean factors emerged (eigenvalues of 2.92 and 1.71) that explained 66.20% of the variance in the data. Factor loadings for the four functional health literacy items ranges from .56 to .90 ($\alpha = .80$); loadings for the three communicative items ranged from .77 to .83 ($\alpha = .76$). The correlation among the two scales was $r = .26$.

Health Numeracy. The health numeracy items were drawn or adapted from the GHNT6 (Osborn et al. 2013) and the Numeracy in Understanding Medicine Instrument Short Form (Schapira et al. 2014). Ten items in total were drafted. Via principal component and item analysis over the two pretests, we ultimately retained eight items that varied in degree of difficulty in terms of correct answers.

Pretest One. We estimated a first principal component factor model for the 10 items and deleted items with factor loadings less than .40. (The two items deleted were identical across the pretest and Study One). We then estimated a second principal components model that produced only one component with an eigenvalue >1 (3.51) that accounted for 43.24% of the variance in the data. Factor loadings ranged from .53 to .73; item-to-total correlations ranged from .41 to .60; scale coefficient $\alpha = .81$; correct responses ranged from 44% to 76%.

Pretest Two. For Pretest Two, only one component with an eigenvalue >1 (2.81) that accounted for 35.21% of the variance in the data was extracted. Factor loadings ranged from .43 to .68; item-to-total correlations ranged from .29 to .50; scale coefficient $\alpha = .73$; correct responses ranged from 46% to 77%.

Main Study. These results replicated for the main study. Only one component with an eigenvalue >1 (2.81) was extracted accounting for 38.53% of the variance; factor loadings ranged from .33 to .72; item-to-total correlations ranged from .23 to .56; scale coefficient $\alpha = .76$; correct responses ranged from 21% to 51%.

Functional Health Literacy Items

How often do you have someone help you read hospital materials? (1 = always to 5 = never), recoded.

How often do you have problems learning about your medical condition because of difficulty understanding written information? (1 = always to 5 = never), recoded.

How often do you have a problem understanding what is told to you about your medical condition? (1 = always to 5 = never), recoded.

How confident are you filling out medical forms by yourself? (1 = not at all to 5 = extremely).

Communicative Health Literacy Items (all scored on 1 = often to 3 = rarely recoded items)

When you talk to a doctor or nurse, do you give them all the information they need to help you?

When you talk to a doctor or nurse, do you ask the questions you need to ask?

When you talk to a doctor or nurse, do you make sure they explain anything that you do not understand?

Health Numeracy Items (*correct answers are bolded after each question*)

James starts a new blood pressure medicine. The chance of a serious side effect is 0.5%. If 1,000 people take this medicine, about how many would be expected to have a serious side effect?

1 person; **5 people**; 50 people; 500 people

The prostate-specific antigen is a blood test that looks for prostate cancer. The test has false alarms so about 30% of men who have an abnormal test turn out not to have prostate cancer. John has an abnormal test result. What is the chance that John has prostate cancer?

0%; 30%; **70%**; 100%

A study found that a new diabetes medicine led to control of blood sugar in 8% more patients than the old medicine. This difference was statistically significant ($p = 0.05$). The likelihood that this finding was due to chance alone is best described as less than:

1 in 5; 1 in 10; 1 in 15; **1 in 20**

If 4 people out of 20 have a chance of getting a cold, what would be the risk of getting a cold?

20%

Suppose that the maximum heart rate for a 60-year-old woman is 160 beats per minute and that she is told to exercise at 80% of her maximum heart rate. What is 80% of that woman's maximum heart rate? Please fill in the number of beats per minute:

128

You ate half the container of carrots. How many grams of carbohydrates did you eat? (Please see the accompanying nutrition label)**12.5 g**

Your doctor tells you that you have high cholesterol. He informs you that you have a 10% risk of having a heart attack in the next 5 years. If you start on a cholesterol-lowering drug, you can reduce your risk by 30%. What is your 5-year risk if you take the drug?

7%

A mammogram is used to screen women for breast cancer. False positives are tests that incorrectly show a positive result. 85% of positive mammograms are actually false positives. If 1,000 women receive mammograms, and 200 are told there is an abnormal finding, how many women are likely to actually have breast cancer?

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