Affective Distancing Associated with Second Language Use Influences Response to Health Information

Renato F. L. Azevedo 1,*, Bidisha Roy 2, Kiel Christianson 3, Yanhong Zhong 4 and Daniel G. Morrow 3

1 Department of Kinesiology and Community Health, University of Illinois Urbana-Champaign (UIUC), Champaign, IL 61820, USA
2 UX Designer at Amazon, Champaign, IL 61820, USA; bidishaxroy@gmail.com
3 College of Education, University of Illinois Urbana-Champaign (UIUC), Champaign, IL 61820, USA; kiel@illinois.edu (K.C.); dgm@illinois.edu (D.G.M.)
4 CheersYou International Consulting, Champaign, IL 61820, USA; yz3709@tc.columbia.edu
* Correspondence: razeved2@illinois.edu

Abstract: Health care delivery depends on effective provider–patient communication. An important issue is whether and how this communication differs for second language (SL) patients. While understanding health information can be impaired by limited English proficiency, we examined a potential benefit of SL use. SL users may be “affectively distanced”, with weaker emotional reactions to content presented in a foreign versus native language (NL). This distancing may have important implications for understanding, and for making decisions and judgements about health information to the extent these processes involve affective responses. For example, patients may respond to diagnostic test results indicating risk of illness with less intense negative affect if the information is presented in their SL. Language differences in affective response may in turn attenuate risk perception for SL versus NL users, with perceived risk being lower while the objective risk associated with test results increases, as predicted by the ‘risk as feelings’ view of risk perception, where perceived risk is based on affective response to the information. On the other hand, risk perception may be more calibrated with objective risk for SL users to the extent that affective distancing encourages SL users to rely on deliberative rather than affective-based, intuitive processes related to risk perception. SL use may also influence attitudes toward and intentions to perform behaviors that address risk because these processes are driven in part by risk perception and memory for the risk information. These processes may also depend on numeracy, defined as the ability to make sense of and rationalize numbers, because it influences risk perception. We tested these predictions in the context of a simulated Electronic Health Record (EHR) patient portal, in which participants were presented diagnostic test results in English from fictional patients. Native English speakers (n = 25), and native Mandarin speakers with higher numeracy (n = 25) and lower numeracy (n = 28) participated in the study. Consistent with the ‘affective distancing’ effect, SL participants with either higher or lower numeracy demonstrated a flatter slope for positive and negative affective responses to the test results compared to NL participants. Moreover, SL participants reported greater perceived risk than NL participants did as objective risk rose. A similar pattern occurred for attitudes toward and intentions to perform behaviors that addressed this risk, especially for treatment health behaviors. On the other hand, language did not influence memory for risk-related information. Our findings extend the affective distancing effect associated with SL use to the health domain and show that this effect influences risk perception and behavioral intentions beyond memory recall and numeracy skills.

Keywords: affective distancing; foreign language effect; health communication
1. Introduction

Managing one’s health requires understanding, making decisions about, and acting on health information. For instance, to understand their cholesterol results, people must interpret the implications of the numbers (Total, triglycerides, HDL, LDL) in terms of risk of cardiovascular disease and decide how to respond to perceived health threats by engaging in self-care behaviors (e.g., eating a healthier diet, taking medications). Health information, traditionally conveyed by providers during office visits, is increasingly conveyed electronically. For example, patient portals to EHR systems provide patients access to their health information, which may support understanding and planning for self-care. Portal-based health information is often numeric, such as test results (Gibbons and Casale 2010; IOM 2012; Stead and Lin 2009).

Understanding health-related numeric information can be cognitively demanding. For cholesterol results, people should understand the risk level indicated by different scores and integrate this information to understand overall risk associated with the results. Each of these scores is also presented in different numeric scales. Moreover, people must consider trade-offs between these numbers: Higher total cholesterol, triglycerides, or LDL numbers indicate more risk, while higher HDL numbers indicate less risk.

An important issue for our health care system is whether and how comprehension and use of health information differs for second language (SL) patients. SL people tend to have limited proficiency in the dominant language of a given healthcare system (in this case, English [ELP]), defined as limited ability to read, write, speak, or understand English (United States Department of the Interior, Office of Civil Rights 2003). According to recent estimates, 25.7 million individuals in the United States are categorized as ELP (Zong and Batalova 2015). Language- and culture-based communication barriers have been linked to poorer health outcomes, in part because ELP can impair comprehension of health-related information (Cohen et al. 2005; Divi et al. 2007; Wilson-Stronks et al. 2008; U.S. Department of Health and Human Services 2012).

Although ELP can impair comprehension of health information among SL individuals, we examined a potential benefit of SL use related to health care. SL individuals may be “affectively distanced,” with weaker emotional reactions to content presented in a foreign versus native language (NL) (Caldwell-Harris 2015; Dewaele 2010; Dewaele 2016; Geipel et al. 2015; Hayakawa et al. 2016; Keysar et al. 2012). This effect can contribute to SL individuals having a reduced negative reaction to emotionally charged information (Colbeck and Bowers 2012; Dylman and Bjärtå 2019). This distancing may also have important implications for understanding and making decisions about health information to the extent that these processes involve affective responses. For example, patients may respond to diagnostic test results that indicate increased risk of illness with less intense negative affect if the information is presented in their SL.

Language differences in affective response to health information may also influence risk perception in at least two different ways. First, risk perception may be attenuated for SL versus NL users. For example, as the level of cardiovascular risk increases for higher LDL numbers, SL users may perceive a smaller increase in risk compared to NL users because they experience less of an increase in negative affect. This prediction is consistent with the ‘risk as feelings’ view of risk perception, where perceived risk is based on affective response to the information (Slovic and Peters 2006; Finucane et al. 2000). For example, people may respond to the risk of severe illness with a feeling of dread, which becomes the basis for judging high levels of risk. If SL use blunts such affective responses, risk judgments may be accordingly constrained.

On the other hand, risk perception may be more calibrated with objective risk for SL users. This prediction is consistent with the claim that affective distancing encourages SL users to rely on deliberative or analytical rather than affective-based, intuitive processes related to risk perception. For example, Keysar et al. (2012) investigated the impact of SL use on the framing effect, in which individuals’ decisions vary based on whether equivalent risks in situations are framed as involving losses, in which case they make risk-seeking...
decisions, or as involving gains, in which case they avoid risk and choose the safer option (Kahneman and Tversky 1979; Kahneman 2003). Participants who read and responded to decision-making scenarios in their native language consistently demonstrated traditional framing effects, reflecting bias in their decision-making process, whereas there was no effect of frame on participants in the SL condition, suggesting they made the rational “mathematically optimal” decision by engaging in more deliberative processes (Corey et al. 2017; Costa et al. 2014; Geipel et al. 2015; Hadjichristidis et al. 2015; Hayakawa et al. 2016). SL use may also influence memory for numeric health information. According to fuzzy trace theories of memory (FTT; Reyna 2011), people understand and remember numeric information at a verbatim and a gist level. The verbatim memory captures the literal facts or “surface form” (e.g., exact numeric values). At the same time, people create gist memory representations organized around goals and knowledge in order to make sense of numbers and to support judgement and decisions. These gist representations tend to reflect qualitative (often affective and evaluative) dimensions. For example, gist memory representations of cholesterol test results may capture ordinal risk values for cardio-vascular diseases (e.g., lower, borderline, and higher risks) as well as corresponding affective/evaluative responses (e.g., good versus bad) (Morrow et al. 2019). SL is unlikely to influence verbatim memory unless encoding is impaired by limited knowledge of number representations in English. Gist memory, on the other hand, may be less accurate for SL versus NL users to the extent that gist is organized around affective responses and SL users rely less on affect to understand and rationalize numeric information. Impaired gist memory among SL users might also contribute to SL-related impairment of risk perception, given the extent that risk perception depends on memory for risk information as well as affective responses to it (Morrow et al. 2019).

Affective responses associated with SL use may also influence intentions to perform behaviors that could address the risks associated with the test results, either by helping to prevent illness (e.g., eating a healthy diet) or by helping to treat illness (e.g., taking medication). According to theories of behavior change (Ajzen and Fishbein 1977; Brewer et al. 2007), health-related behavioral intentions are associated with attitudes related to the behaviors, which in turn depend on risk perception. Therefore, SL use may increase or decrease behavioral intentions, depending on its relation to risk perception and affect. Affective responses can also directly influence attitudes and attitude changes (Forgas 2008).

An alternative account of SL judgment and decision-making in medical and other contexts relies on cognitive “fluency,” or metacognitive impressions of the relative difficulty of operations over information or processes (Alter et al. 2007; Oppenheimer 2008; Segalowitz 2010). Under this account, rather than affective distancing in the SL, differences in results between NL and SL participants would be predicted to arise as a result of cognitive costs imposed by less fluent English processing in the SL participants. For example, perceived disfluency may itself distance people from the risk information and encourage deliberative processing. The predictions under this account are the same as under the affective distancing account, as both decreased fluency and decreased affective response would tend to promote so-called System 2 processing (i.e., deliberate, analytical) (Alter et al. 2007; Kahneman and Frederick 2002) over so-called System 1 processing (i.e., heuristic, intuitive). We will return to this alternative account in the Discussion.

We examined the impact of SL use on affective response, risk perception, and memory related to numeric health information in the context of a simulated Electronic Health Record patient portal. Patient portals have become a widespread means of conveying health information, especially numeric information such as clinical test results. At the same time, they are underutilized by patients, especially those who are nonwhite and SL users (Ancker et al. 2011; Goel et al. 2011). Thus, portals provide an important context for evaluating the impact of SL use in health care.
As in Morrow et al. (2019), participants evaluated scenarios presented in English, with fictitious patient profiles and messages describing results for these patients from cholesterol screening tests, which indicated lower, borderline, or higher risk levels. These cholesterol messages were presented in a ‘verbally enhanced’ format, with labels for evaluative categories. We measured participants’ memory for, as well as affective and risk perception responses to, the cholesterol information presented, as well as their attitude toward and intention to perform self-care behaviors related to risk. We predict that SL participants would respond with an attenuated affective response (be “affectively distanced”) to health risk information presented compared to NL participants. We tested competing predictions about the impact of SL use on risk perception and memory related to health information, derived from alternative theoretical perspectives related to the influence of affective response on risk perception and memory, and the subsequent effects of language on attitude and intentions to perform self-care behaviors.

Finally, we investigated the impact of numeracy as well as language use. Numeracy, defined as the ability to make sense of and reason about numbers (Peters 2012), influences risk perception by supporting the ability to evaluate probability and severity of risk-related outcomes (Garcia-Retamero and Cokely 2011). Numeracy may also influence the ability to encode and retain numeric information (Peters 2012). Therefore, numeracy may influence how our participants respond to risk-related information independently of language-related differences.

2. Materials and Methods

2.1. Participants

The study was approved by the University of Illinois Urbana-Champaign institutional review board. Participants provided consent before participation. Participants were students at a large Midwestern university who were Native English speakers (n = 25, average age of 19.9 years, 60% female) or native Mandarin speakers (n = 53, average age of 20.6 years, 75.8% female). Two groups of Mandarin speakers (SL) were recruited to allow us to investigate potential effects of numeracy as well as SL use. The literature suggests that Mandarin speakers often outperform English NL users in the United States (Klaczynski et al. 2019; Wang and Lin 2005). Hence, the SL group was divided into those with higher (n = 25) and lower (n = 28) numeracy skills (measured by the Berlin Numeracy Test [BNT]; lower numeracy defined as ≤50% on the BNT measure; Cokely et al. 2012). A one-way between-subjects ANOVA (F(2,75) = 52.0, p < 0.001, \(\eta^2 = 0.58\)) was followed up by Bonferroni pairwise comparisons, which showed that the English (NL) group had comparable numeracy skills to the lower numeracy SL group, and both groups were lower than the higher numeracy SL group (SL lower numeracy: 0.35; NL: 0.44 < SL higher numeracy 0.86; proportion correct—BNT). All participants were screened for cognitive, visual/auditory, or physical impairments that could limit participation.

Table 1 shows that the groups were comparable in speed of processing and, as expected, the NL group outscored the SL group on the ELP measures.
Table 1. Demographic information for the language groups.

<table>
<thead>
<tr>
<th></th>
<th>SL Group: Higher Num. (HN)</th>
<th>SL Group: Lower Num. (LN)</th>
<th>NL Group</th>
<th>Test</th>
<th>Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Years of US Residence</td>
<td>2.84 (2.65)</td>
<td>3.89 (4.09)</td>
<td>19.13 (1.09)</td>
<td>F(2,75) = 257.4, p &lt; 0.001,(\eta^2 = 0.87)</td>
<td>NL &gt; SL HN p &lt; 0.001, d = 7.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 257.4, p &lt; 0.001,(\eta^2 = 0.87)</td>
<td>NL &gt; SL LN p &lt; 0.001, d = 5.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 257.4, p &lt; 0.001,(\eta^2 = 0.87)</td>
<td>SL HN and SL LN p = 0.57, ns, d = 0.31</td>
</tr>
<tr>
<td>Mean Self-Reported ELP</td>
<td>7.75 (1.08)</td>
<td>8.00 (1.29)</td>
<td>9.88 (0.33)</td>
<td>F(2,75) = 35.3, p &lt; 0.001,(\eta^2 = 0.49)</td>
<td>NL &gt; SL HN p &lt; 0.001, d = 2.61</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 35.3, p &lt; 0.001,(\eta^2 = 0.49)</td>
<td>NL &gt; SL LN p &lt; 0.001, d = 1.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 35.3, p &lt; 0.001,(\eta^2 = 0.49)</td>
<td>SL HN and SL LN p = 1.00, ns, d = 0.21</td>
</tr>
<tr>
<td>Vocabulary Score (ERVT-V3)</td>
<td>0.34 (5.30)</td>
<td>0.34 (5.30)</td>
<td>4.84 (4.73)</td>
<td>F(2,75) = 6.8, p &lt; 0.01,(\eta^2 = 0.15)</td>
<td>no differences</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 6.8, p &lt; 0.01,(\eta^2 = 0.15)</td>
<td>NL and SL HN p &lt; 0.69, ns, d = 0.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 6.8, p &lt; 0.01,(\eta^2 = 0.15)</td>
<td>NL and SL LN p &lt; 0.23, ns, d = 0.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 6.8, p &lt; 0.01,(\eta^2 = 0.15)</td>
<td>SL HN and SL LN p = 1.00, ns, d = 0.18</td>
</tr>
<tr>
<td>Speed of Processing (Pattern Comparison)</td>
<td>23.30 (3.34)</td>
<td>23.90 (3.34)</td>
<td>22.18 (3.44)</td>
<td>F(2,75) = 1.7, p = 0.195, ns, (\eta^2 = 0.04)</td>
<td>SL HN &gt; SL LN p &lt; 0.001, d = 3.53</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 1.7, p = 0.195, ns, (\eta^2 = 0.04)</td>
<td>SL HN &gt; NL p &lt; 0.001, d = 2.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F(2,75) = 1.7, p = 0.195, ns, (\eta^2 = 0.04)</td>
<td>SL LN and NL p = 0.32, ns, d = 0.40</td>
</tr>
</tbody>
</table>

\(^1\) Values denote averages and parentheses standard deviations.

2.2. Scenarios

All materials and measures were presented in American English. Six scenarios with fictitious patient profiles that contained descriptions of the patient’s results from cholesterol screening tests were developed by working with two physician collaborators. The described results contained complex patterns of scores across multiple components—total cholesterol, triglycerides, high-density lipoproteins (HDL), and low-density lipoproteins (LDL), which in combination suggested low, borderline, or high risk for cardio-vascular illness. To help patients understand the overall risk for each message, a summary of the overall risk associated with the four component scores followed each message. Because these risk levels reflect patient-specific factors (e.g., family history of cardio-vascular diseases) as well as the scores, patient profiles were included in each message. The messages were presented in table format with scores accompanied by minimal description of their respective scales, similar to test results found in actual patient portals (see Figure 1 below). In addition, the table was ‘verbally enhanced’ with labels for evaluative categories (more versus less risk) and additional information about the regions of risk associated with the scale for each score. This additional information provided context to help participants interpret the specific numbers.
evaluative categories (more versus less risk) and additional information about the regions of risk associated with the scale for each score. This additional information provided context to help participants interpret the specific numbers.

Figure 1. Verbally Enhanced Cholesterol Message (Morrow et al. 2017; Morrow et al. 2019).

Similar labels have been found to support affective processing of numeric information, which support gist understanding (Peters et al. 2009). As described, these benefits may be less likely for the SL compared to NL participants in the study.

2.3. Individual Difference Measures

2.3.1. English Language Proficiency (ELP)

Self-reported ELP, history of English language acquisition, and percentage of social interaction in English was measured using a modified version of a language history questionnaire (ACTFL 2012; Sheng et al. 2014). Participants rated their ELP on an ordinal ten-point scale modified from the American Council of Teaching of Foreign Languages’ (ACTFL) Speaking Proficiency Guidelines, with the following proficiency levels: Superior (10), Advanced High (9), Advanced Low (7), Intermediate High (6), Intermediate Mid (5), Intermediate Low (4), Novice High (3), Novice Mid (2), and Novice Low (1). This measure is widely used in foreign language testing in the U.S. (Dandonoli and Henning 1990; Liskin-Gasparro 2003) and is often used to evaluate functional language ability in academic and workplace settings (ACTFL 2012). Native English speakers rated their ELP levels as well as any other language(s) they may have been familiar with, and Native Mandarin speakers did the same for Mandarin, English, and any other languages. ELP was also objectively measured by the Extended Range Vocabulary Test, Version 3 (ERVT-V3) (Ekstrom et al. 1976). This measure consists of 24 items for which participants choose the best synonym out of five possible answers per item.

2.3.2. Numeracy and Cognitive Ability

Numeracy was measured by the Berlin Numeracy Task (BNT), a brief and validated measure of statistical numeracy and risk literacy (Cokely et al. 2012). Higher scores on the BNT reflect better numeracy. In addition, cognitive ability relevant to understanding health information was measured by the Pattern Comparison test (Salthouse and Babcock 1991). This nonverbal measure of processing speed has been shown to predict recall of medical information (Morrow et al. 2012).
2.4. Dependent Measures

2.4.1. Message Memory

Verbatim memory for the individual scores (e.g., HDL) was scored in two ways: (i) strict score, where correct performance required recalling the exact value of the test score presented in the message; (ii) liberal score, where performance was scored as correct if the recalled number was within five numbers above or below the exact value presented in the message. Gist memory was measured at two levels: (i) risk associated with each individual score (e.g., HDL) in the message; (ii) global risk associated with the overall message (ordinal level gist: low, borderline, and high; Reyna et al. 2009). Global risk was measured both before and after the second part of the message (summary statement) in order to investigate how well participants understood the overall gist based on only the component scores, which required inferring the overall level of risk by integrating the risk implications of the individual scores.

2.4.2. Affective Reactions

Participants indicated how much they experienced seven negative and seven positive emotions in response to each scenario by completing, for each emotion, Likert scales. The scales ranged from 1 (not at all) to 9 (very much). For example, “If you were the patient Sandra, how would you feel as you watched this message? Indicate the extent that you felt: assured, calm, cheerful, happy, hopeful, relaxed, and relieved; or anxious, afraid, discouraged, disturbed, sad, troubled, and worried” (Garcia-Retamero and Cokely 2011).

2.4.3. Risk Perception

Participants’ perceived risk associated with each scenario was measured by indicating on a scale (1 = Very unlikely; 9 = Very likely) how likely they were to develop heart disease and heart-related complications if nothing was done to address the reported cholesterol levels, assuming they were the patient described in the scenario (Garcia-Retamero and Cokely 2011).

2.4.4. Intention to Perform Self-Care Behaviors

Participants’ intention to perform behaviors that might address the risk associated with the test results was also measured. They indicated (9-point scale: 1 = I have no intention of doing this; 9 = I am certain that I would do this) their intention, if they were the patient in the scenario: (1) how likely were they to take medication prescribed to reduce cholesterol; (2) how likely were they to change their diet; and (3) how likely were they to increase their level of exercise (adapted from Garcia-Retamero and Cokely 2011).

2.4.5. Attitude toward Taking Medication

Participants also indicated (9-point scale: 1 = not at all; 9 = very much) how favorable they would feel about taking medications prescribed for lowering cholesterol, if they were the patient in the scenarios (Garcia-Retamero and Cokely 2011).

We conducted a Principal Component Analysis (PCA) for reducing the dimensionality of these four measures of self-care behaviors. Two components retained 93.76% of the information (see Figure 2) and were labelled for analysis as Preventive Health Behaviors (combining intent to exercise and intent to change diet; \( \alpha = 0.92 \)) and Treatment Health Behaviors (combining intent and attitudes towards taking cholesterol medications; \( \alpha = 0.94 \)).

2.5. Procedure

The study session lasted approximately one hour. After providing informed consent and demographic information, participants completed paper versions of the ELP measures. Next, they completed the simulated patient portal tasks on a computer at their own pace. Finally, they completed the numeracy and speed of processing measures.
Languages 2022, 7, x FOR PEER REVIEW 8 of 16

Figure 2. Principal Component Analysis: Preventive and Treatment Health Behaviors.

2.6. Study Design

The presentation of the six cholesterol scenarios were blocked by risk level, with two messages at each risk level (low, borderline, and high) being presented together. A practice scenario was included to familiarize participants with the structure of the trials and the measures. Language (English/NL vs Mandarin/SL) was a between-group factor. Numeracy level was varied within the SL group until both lower and higher numeracy SL subgroups had a minimum sample size equivalent to the NL group sample size. This allowed us to evaluate the effects of numeracy as well SL use on performance.

3. Results

3.1. Correlations among Variables

Simple Pearson’s correlations among the participant ability measures replicated usual patterns described in the cognitive psychology literature and in studies on the so-called foreign language effect (see Appendix A for a complete table). Measures of vocabulary ability (Ekstrom et al. 1976), ELP (ACTFL 2012; Sheng et al. 2014), and years of US residence were correlated, suggesting a verbal ability/language proficiency construct, which characterizes the differences between NL and SL learners. Negative correlations indicate the association with the dummy variable SL (1: yes/0: no), supporting the expectation that the NL group would outscore the SL group on the ELP measures. Furthermore, we also explored associations of these individual ability variables with differences in memory for and responses to the health messages. Whereas SL and NL participants did not differ in memory for the cholesterol information presented (verbatim and gist memory; see below), the correlation results supported the prediction that SL participants were “affectively distanced”, showing weaker emotional reactions to cholesterol information presented in a foreign versus native language ($r = -0.24$). In addition, SL participants reported greater perceived risk ($r = 0.36$) and a higher intention to take medications ($r = 0.25$) compared to NL participants as objective risk associated with the cholesterol test results rose.

3.2. Memory Accuracy

We investigated effects of language on memory for the cholesterol information at two levels: (1) verbatim- and gist-level memory for the individual test components (e.g., HDL vs LDL) with memory averaged across the components; (2) gist memory for overall risk associated with the test results, both before and after the summary statement in the message. Memory for the component scores was analyzed by a 3 (Groups: NL; SL with high numeracy; SL with low numeracy) x 2 (Memory type: verbatim, gist) mixed design analysis of
variance (ANOVA: memory type as repeated measure). Consistent with FTT (Reyna 2011), gist memory for the presented information was more accurate than verbatim memory ($F(2,149) = 74.8, p < 0.001, \eta^2 = 0.33$; gist: 0.760 > verbatim: 0.488; accuracy proportion).

NL and SL participants did not differ in memory accuracy ($F(2,149) = 0.45, p = 0.637$, ns, $\eta^2 = 0.01$, NL speakers: 0.632; SL with low numeracy: 0.620; SL with high numeracy: 0.620), and the group x memory type interaction was not significant ($F(2,149) = 0.43, p = 0.654$, ns, $\eta^2 = 0.01$), suggesting that the NL and SL groups did not differ in either verbatim or gist memory for the test results.

Next, gist memory accuracy for the overall risk associated with the cholesterol information was analyzed by a 3 (Groups) x 2 (Time: before and after summary statement) mixed design analysis of variance (ANOVA: time as repeated measures). Overall gist memory was comparable across the groups ($F(2,149) = 2.08, p = 0.13, \eta^2 = 0.02$; NL = 0.850; SL lower numeracy = 0.880; SL higher numeracy = 0.872; proportion correct). The Group x Time interaction was not significant ($F(2,149) = 0.49, p = 0.611$, ns, $\eta^2 = 0.01$). Memory improved, as expected, after the summary statement was presented ($F(1,149) = 53.44, p < 0.001, \eta^2 = 0.26$; after: 0.955 > before summary: 0.780; accuracy proportion).

3.3. Affective Response

Consistent with the ‘affective distancing’ hypothesis, SL participants demonstrated a flatter slope for affective responses to the test results compared to NL participants ($F(2,75) = 4.60, p < 0.05, \eta^2 = 0.06$; Bonferroni pairwise comparisons NL > SL speakers with high and low numeracy skills\(^1\)). In other words, SL participants’ affective response to changing risk associated with the test results was attenuated compared to NL participants.

A follow-up analysis extended these findings, revealing the ‘affective distancing effect’ for both positive ($F(2,75) = 11.18, p < 0.001, \eta^2 = 0.23$; NL = 2.50 < SL high numeracy = −1.82 and SL low numeracy = −1.61; average slope coefficients) and negative affective responses ($F(2,75) = 8.36, p < 0.001, \eta^2 = 0.18$; NL = 2.50 > SL high numeracy = 1.99 and SL low numeracy = 1.69; average slope coefficients). More specifically, SL participants reported less increase in negative affect as objective risk increased compared to NL, and conversely, less increase in positive affect. Importantly, this effect was significant regardless of SL numeracy skills\(^2\) (see Figure 3).

![Figure 3. SL and NL Positive and Negative Affective Responses.](image)

3.4. Risk Perception

Consistent with the claim that affective distancing encourages reliance on deliberative rather than affective-based processes related to risk perception, SL participants reported greater perceived risk than NL participants did as objective risk rose (steeper slope
(F[2,75] = 5.69, p < 0.01, η² = 0.13; NL = 1.85 < SL high numeracy = 2.63 and SL low numeracy = 2.52; average slope coefficients).

3.5. Preventive Health Behaviors (Intent to Exercise and Change Diet)

While SL and NL participants did not significantly differ in their intentions to engage in preventive health behaviors (F[2,75] = 0.77, p = 0.465, ns, η² = 0.02; NL = 1.22; SL high numeracy = 1.35; and SL low numeracy = 1.53; average slope coefficients), the numerical pattern across groups are similar to the language-related effects for risk perception.

3.6. Treatment Health Behaviors (Intent and Attitudes towards Taking Medications)

Also consistent with the claim that affective distancing encourages reliance on deliberative rather than affective-based processes related to risk perception and behavioral changes, SL participants reported greater behavioral intention and attitudes towards taking medications than NL participants did as objective risk rose (steeper slope (F[2,75] = 3.29, p < 0.05, η² = 0.08; NL = 1.86 < SL high numeracy = 2.29 and SL low numeracy = 2.62; average slope coefficients).

4. Discussion

We examined NL and SL participants’ affective responses to, and memory for, numerical health data presented in the context of a simulated Electronic Health Record patient portal. We also examined perception of risk associated with this information and intentions to perform behaviors that would address this risk. Based on the ‘affective distancing’ view of SL use, we expected an attenuated affective response to health risk information for SL versus NL users. Competing predictions about the impact of SL use on risk perception were derived from alternative theoretical perspectives. First, consistent with the ‘risk as feelings’ view of risk perception, where perceived risk is based on affective response to the information (Finucane et al. 2000; Slovic and Peters 2006), risk perception may have been attenuated for SL versus NL participants, with perceived risk lower as the objective risk associated with cholesterol test results increased. Alternatively, risk perception may have been better calibrated with objective risk for SL participants. This prediction is consistent with the claim that affective distancing encourages SL users to rely on deliberative rather than affective-based, intuitive processes related to risk perception and choices (Keysar et al. 2012; Hadjichristidis et al. 2015; Hayakawa et al. 2016).

Our findings support the affective distancing view. SL participants reported a flatter increase in negative affect as the objective risk for cardio-vascular illness associated with the test results increased. In addition, their perceived risk was greater compared to the NL participants as the objective risk increased. These patterns did not depend on participants’ numeracy skills. For example, the lower numeracy SL group had an attenuated affective response to risk information compared to the NL group, even though these two groups did not differ in numeracy. Moreover, reflecting these differences in risk perception, the SL participants’ reported intentions to perform behaviors that might treat illness (taking medication) were more calibrated to risk, compared to NL participants. The same pattern occurred for intentions to perform behaviors that may prevent illness (e.g., eating a healthy diet), although the group differences were not statistically significant. Behavioral intentions, being conceptually close to health-related actions, suggest that SL use may relate to health outcomes.

The results related to memory for the health-related information were more complex. Based on FTT (Reyna 2011) we had predicted that SL participant gist memory would be impaired compared to NL participants because they would be less likely to organize gist in terms of affective distinctions. However, SL and NL participants did not differ in their gist-based memory. This finding may reflect the fact that the encoding and retrieval of health information is influenced by many factors in addition to ELP, such as interest in and knowledge of health topics (Beier and Ackerman 2003). Consistent with FTT (Reyna 2011), verbatim memory for the test results was less accurate than gist memory, and as predicted, was not influenced by language group.
Finally, we return to the alternative explanation for the affective distance effects related to cognitive fluency (Oppenheimer 2008; Segalowitz 2010). This account proposes that the increased processing or cognitive load associated with operating in one’s non-native language promotes more “System 2” analytical, deliberative decision-making processes (Alter et al. 2007). Although our data do not rule out this proposal, two aspects of the current results appear difficult to square with a fluency-based interpretation. First, recall that we compared two SL groups to NL speakers: those with lower and those with higher numeracy (the lower SL group did not differ from the NL group in numeracy). If cognitive fluency—or the perceived difficulty of operations—were driving our effects, then the lower-numeracy SL and NL groups should have behaved more similarly, given that both could be assumed to devote more effort to the numerical data provided in the materials. We might even have predicted that lower-numeracy SL participants would have performed differently from both higher-numeracy SL and NL groups, given that they plausibly experienced greater cognitive disfluency with both the linguistic and numerical aspects of the materials. Instead, the lower-numeracy SL group performed similarly to the high-numeracy SL group. Second, we explicitly measured affective response, and found a difference between SL and NL groups—a result that is easier to interpret from an affective distance perspective. Finally, we note that disfluency effects in our study are difficult to evaluate both because perceived fluency was not directly measured and because the concept of fluency may itself involve affective as well as cognitive processes (Schwarz and Clore 2007).

Our findings regarding how SL use influences patients’ understanding of and response to health information, have theoretical and practical implications. Theoretically, we extend the affective distancing effect associated with SL use to the health domain and show that this effect influences risk perception, which has been shown to influence health decisions and some behaviors (e.g., treatment health behaviors). Future studies, less limited by sample size, could further evaluate predictions based on our results using other types of health scenarios and tasks. More practically, our findings suggest a potential benefit of SL use by non-native English speakers, an increasing proportion of the patient population in the United States. Reduced reliance on affect-based processes and an increased reliance on deliberative processes related to risk perception may help mitigate decision-making biases related to understanding the risk implications of health information, so long as this information is understood in the first place.


**Funding:** This work was supported by the Agency for Healthcare Research and Quality [grant number R21HS022948].

**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of The University of Illinois Urbana-Champaign (protocol code 14545; 13 January 2020).

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Acknowledgments:** This research relates to the capstone projects of the co-authors: Bidisha Roy (Psychology) and Yanhong Zhong (Learning & Education Studies). We are grateful to Charles Lansford and William Schuh for their expert advice about the construction of the scenarios.

**Conflicts of Interest:** The authors declare no conflict of interest.
### Appendix A

#### Table A1. Means, Standard Deviations, and Pearson’s Correlations with Confidence Intervals (n = 78).

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SL (1 - Yes/0 - No)</td>
<td>0.66</td>
<td>0.47</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Years US</td>
<td>8.40</td>
<td>7.96</td>
<td>-0.95**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. ELP</td>
<td>5.51</td>
<td>3.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Vocabulary</td>
<td>8.51</td>
<td>5.51</td>
<td>-0.28**</td>
<td>0.41**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Speed of Processing</td>
<td>23.13</td>
<td>11.51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Numeracy</td>
<td>0.56</td>
<td>0.30</td>
<td>-0.93**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Verbatim Memory</td>
<td>0.23</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Gist Memory</td>
<td>0.56</td>
<td>0.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Overall Gist</td>
<td>0.76</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Affective Response</td>
<td>-2.01</td>
<td>0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Risk Perception</td>
<td>2.55</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Preventive Behaviors</td>
<td>1.37</td>
<td>0.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Treatment Behaviors</td>
<td>2.25</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. M and SD are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. * indicates \( p < 0.05 \), ** indicates \( p < 0.01 \).
Notes

1 Positive affective responses: NL > SL HN, \( p = 0.002, d = 1.03 \); NL > SL LN, \( p < 0.001, d = 1.18 \); SL HN and SL LN, \( p = 0.858, ns, d = 0.30 \). Negative affective responses: NL > SL HN, \( p < 0.05, d = 0.78 \); NL > SL LN, \( p < 0.001, d = 1.10 \); SL HN and SL LN, \( p = 0.365, ns, d = 0.41 \).

2 For the sake of completeness, we also ran an analysis of covariance (ANCOVA) obtaining the same patterns of results.

References


Corey, Joanna D., Sayuri Hayakawa, Alice Foucart, Melina Aparici, Juan Botella, Albert Costa, and Boaz Keysar. 2017. Our moral choices are foreign to us. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 43: 1109. [CrossRef]


Dewaele, Jean-Marc. 2016. Thirty shades of offensiveness: L1 and LX English users’ understanding, perception and self-reported use of negative emotion-laden words. *Journal of Pragmatics* 94: 112–27. [CrossRef]


Dewaele, Jean-Marc. 2016. Thirty shades of offensiveness: L1 and LX English users’ understanding, perception and self-reported use of negative emotion-laden words. *Journal of Pragmatics* 94: 112–27. [CrossRef]


