Building Instruments to Measure the Effect of Rhetorical Roles on Reading Strategy: Some Evidence against Using Readability Formulas to Equalize Texts

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INTRODUCTION

Silent reading is a solitary, personal experience. The enigmatic context in which a reader and text meet has been thoroughly explored by literary critics and theorists. Structuralists, also known as positivists, insist that the meaning engendered during the reading of a text is always constrained by “the implicit codes of the inherited system” [1, p. 243]. The meaning of a text, according to structuralists, can be determined objectively—even scientifically—through a linguistic prism. To add credibility to their science, early structuralists borrowed from the compelling and innovative *Course in General Linguistics* by the Swiss linguist Ferdinand de Saussure [2].

On the other hand, deconstructionists, also called poststructuralists, maintain that the meaning of a text is objectively indeterminable. Champions of indeterminacy, such as Stanley Fish [3], reject the constructionist theory that “truth” or objective meaning resides in the structure of a text. Instead, deconstructionists claim that the reader creates meaning during the reading process, resulting in a different meaning from any other reader or even from the same reader at different times. In “The Death of the Author,” Barthes claims that the author of a text is essentially dead when the reader experiences the text, that “the birth of the reader must be at the cost of the death of the Author” [4, p. 172]. Thus a text is not a medium through which a writer communicates to a reader.

Although both sides of the determinacy/indeterminacy polemic still yield some provocative ideas about the relationship between a reader and a text [5], they do not consider more practical questions about the reading process. Researchers in other disciplines such as linguistics, physiology, and experimental psychology took up the challenge of exploring the intricacies of the reading machinery. Huey’s seminal study of the reading process sparked an era of scientific

interest. Published in 1908 [6], *The Psychology and Pedagogy of Reading* chronicles the first attempts to use modern metrics to measure such reading characteristics as speed and silent speech. Other notable reading researchers, such as O'Brien and Smith [7]–[8], have championed the pedagogy of reading as a logical application of reading research.

Based upon what researchers have discovered about reading, models have been created to explain the relationships among the components of the reading process. Figure 1 shows a typical simplified model of the reading process, indicating its three stages: (1) looking for words, (2) identifying words, and (3) synthesizing words to create meaning. Long-term memory, which has a nearly infinite capacity to hold information [9, p. 103], is a reservoir of attitudes, assumptions, and expectations that bear upon reading strategy.

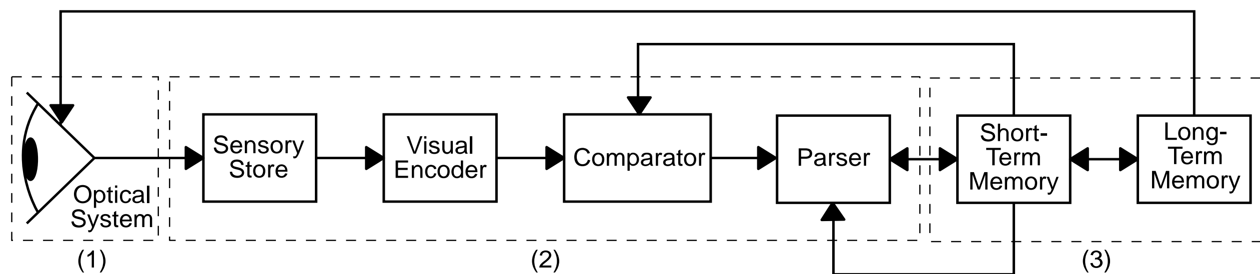


Fig. 1. A model of the reading process.

Although some published information claims that the average person reads about 250 words a minute [8] [10], the speed and accuracy of reading depends upon many factors. Besides variation in reading strategy from reader to reader, there is also the potential for variation within each reader. The ability to willfully change reading rates is called *flexibility.* Positive flexibility is a *decrease* in reading rate as the difficulty of the reading task increases. Negative flexibility is an *increase* in reading rate as task difficulty increases. McCracken divided reading flexibility

into two types: external and internal [11]. External flexibility is flexibility between texts, whereas internal flexibility is flexibility within the same text. Researchers have shown that internal reading flexibility depends upon the purpose for reading [12]–[19], knowledge of the topic of the text [20]–[21], reading skill [22], maturity of the reader [23]–[24], and difficulty of the text [17]–[25].

Text difficulty, a concept highly involved in the present study, has been correlated with the activation of silent speech. During silent reading, printed words are automatically converted to a phonological code, which produces a physical signal that engages the speech apparatus [26]. Although silent speech may not be involved in all semantic tasks of the reading process, it is likely to be highly activated during tasks that place demands on memory, such as reading difficult material [27]–[28]. In other words, when readers encounter "difficult, infrequent, or unfamiliar material" [29, p. 241], pronunciation of words is essential to understanding. Because the phonemic channel of the reading process carries information more slowly than the visual channel, silent speech is a prime candidate for explaining internal flexibility.

However, there remains—for sound reasons—stiff opposition to the idea of internal flexibility [30]. Experimental results that support internal flexibility may be flawed because those experiments induced highly improbable readers. For example, subjects are often given ambiguous or vague prereading instructions. Subjects are told to read a passage rapidly but carefully [25], to read quickly while learning as much as possible, "to read the passage as fast as possible, consistent with good comprehension" [20, p. 568], or "to read the selection as rapidly as possible and still understand it sufficiently to answer questions afterwards" [17, p. 238]. On the other hand, "If no purpose is given, students will not know whether they should read for overview or for detail" [25, p. 605]. The result is a "laboratory reader," a reader who tries to

conform his reading behavior to perceived desires of the experimenter. Differences in measured reading speed may therefore be an artifact of the measurement rather than real differences [30].

One way to prevent the problem of ambiguous instructions is to clarify all prereading directions and administer a practice trial that approximates the real trial [25] [31]. However, another way is to completely conceal the purpose of the experiment. Emphasizing reading time creates a demand effect, which is the subjects' interpretation and enactment of what the experimenter is looking for. Thus if the subject knows that reading time is an important element of the experiment, she may quickly run her eyes across the page without really reading. However, the purpose of the experiment is rarely concealed from the subjects. When reading rates are self-reported, the demand effect is compounded. Given the high probability of demand effects, self-recorded reading times are likely to be distorted [14].

Although the data supporting internal flexibility are ambiguous at best, external flexibility enjoys nearly unanimous support. Even Carver, an exceptionally vehement opponent of the internal-flexibility hypothesis, accepts the theory of external flexibility, calling it the "gear-shifting premise" of his "rauding theory" [32, pp. 17–23]. Just as drivers shift gears in expectation of different terrains, readers shift strategic gears depending on the purpose for reading. "For example, readers who decide to study the [text] will focus their eyes on every bit of information it contains, perhaps even moving their eyes back over passages they did not grasp at first" [33, p. R-249]. On the other hand, reading for specific information (skimming) may be twice as fast as reading for comprehension.

Much of external flexibility may be explained by conscious changes in reading strategies. For nearly a century, reading teachers have instructed their pupils to read texts flexibly

depending on purpose and text type [7] [34]. For example, McWhorter suggests three reading rates based on purpose:

1. Reading for a Test: 150 to 250 words per minute
2. Reading for Pleasure: 250 to 400 words per minute
3. Reading for a specific fact: 600 words per minute or higher [35]

Carver, on the other hand, is more exacting. He suggests five basic reading *processes* based on typical reading rates of college students:

1. Scanning: 600 words per minute
2. Skimming: 450 words per minute
3. Reading for Comprehension (Rauding): 300 words per minute
4. Learning: 200 words per minute
5. Memorizing: 138 words per minute [32, p. 14]

However, teaching methods designed to instill external flexibility have had mixed results, with some instruction methods resulting in improved flexibility and others resulting in little or no change in flexibility [36].

While the vast majority of reading-flexibility experiments depend upon conscious, willful changes in reading strategy, there is strong evidence that readers unconsciously adapt to various readings tasks. For example, readers bring an agenda—or set of expectations and assumptions—to every text they read, which can enhance or obstruct the reader's understanding of the text [33[[37]. Reader expectations about certain reading tasks are formed incrementally during the reader's experiences with various types of texts during various conditions. Psychological constructs for each experienced text type, or genre, are thus formed. Expectations that surface

from these constructs may influence comprehension and recall [38]. Recognizing a genre enables the reader to quickly access prior knowledge about that genre to set a reading strategy.

Psychological constructs that bear upon the reading process have been explained by schema theory, which proposes that people classify experiences based upon cognitive network formed in long-term memory. Each experience is therefore understood in the context of past experiences. The selective attention hypothesis of schema theory is one proposed explanation for text-processing strategies [21]. According to this hypothesis, a reader "selects important or relevant text elements and then devotes more time to these than to other less important elements [21, p. 316]. The reader thus spends more time on schematically important elements so that those elements can be incorporated into the active schema [39].

Reading flexibility resulting from schematic organization is unconscious and powerful. The reader, based upon experiences with various genres, imposes a structure on every text, viewing a text from an established cognitive framework [40]. Studies show that consciously evoked points of view affect comprehension and recall, as well as reading speed [39]–[40]. These studies support the notion that a reader may assume a different rhetorical role for each particular genre in her repertoire of reading experiences, thus fixing her reading strategy according to her perceived demands of a text. By predicting the level of difficulty, the reader enters a text and navigates with a level of deliberation evoked by a particular schema.

Coney has been exploring the idea of *rhetorical roles* in technical and science communication for two decades [41]–[43]. Asserting that readers always read within a role, she and Thompson posited an intriguing conclusion of recent research, "that a significant force in determining and controlling the role of the reader originates in the reader, and that this force is quite independent of the role created by the author through the text" [43, p. 108].

Rhetorical roles set the boundaries for reading strategy. For example, during the leisurely act of reading fiction for pleasure, a reader may make expansive assumptions and predictions, whereas the reader of technical prose may make cautious and deliberate movements in the text. The emotionally charged curiosities of the fiction reader may hop over wayward punctuation, skirt ambiguities, and cut through linguistic entanglements that would separate a technical reader from a text, thereby stopping the reading process. The consequences of not fully retaining the details of fiction are negligible, whereas not fully retaining the details of a technical document could have adverse and even perilous consequences. The differences in these two reading strategies should be detectable by modern metrics used in experimental psychology.

The questions for the present study are these: Is there in every reader an *unconscious* set of expectations based upon experience with different genres and internalized instructions to read at different rates according to purpose and genre? Further, have the various failures of technical communicators to communicate clearly hardened the technical reader against the technical genres, reinforcing expectations of difficult, problematic reading? Are expectations of technical difficulty a road sign that cautions wordfaring people to "Reduce Speed Ahead"? Is *genre* a legitimate psychological construct that bears upon the reading process and alters reading strategies?

There is now a substantial body of evidence supporting the notion that text alone does not create a careful reader. Careful reading is not just a reaction to a difficult text, but is in part the result of the rhetorical role adopted by the reader. For the present study, I define *carefulness* as the amount of time a reader spends attending to a text. Reading researchers often operationalize the level of reader attention as reading speed [14] [39]. However, measuring attention is but a part of determining the effect of the reader's rhetorical role upon reading strategy. For example,

the psychological construct of genre is composed of both a conscious purpose and unconscious expectations of text difficulty. To determine the effect of unconscious expectations evoked by a particular rhetorical role, those expectations must be isolated from all other confounding variables, such as text difficulty and conscious purpose.

The long-term purpose of the current study is to invoke a reader's schema related to a particular genre of text, thus inducing a rhetorical role whose characteristics can be measured and differentiated from other rhetorical roles. If genre is indeed a legitimate psychological construct—a high-level schema—then the engagement of this construct before the reading process begins should affect reading strategy (speed) as well as comprehension and recall. Those who read a technical description or news story for information will spend more time addressing the text than those who read a short story for entertainment.

The goal of this preliminary stage of the study is to develop an experimental method to isolate the effect of the reader's rhetorical role on reading strategy. It is hypothesized that careful reading is in part a product of the reader's rhetorical role. The experimenter suggests three requisites for isolating the effect of rhetorical roles: 1) *indirectly* induce a particular rhetorical role, 2) experimentally control the difficulty of each text across treatment groups, and 3) statistically control differences in subject-to-subject reading speed. No study reviewed thus far has met these three requisites. Therefore, before an experiment can be conducted, instruments must be crafted, tested, and refined.

An obvious starting point is the method of induction. That is, how can a particular rhetorical role be *indirectly* induced? How can a reader adopt a particular role without directly being told to do so? Furthermore, the texts used in each treatment group must not deny the reader's

expectations. A reader who expects to read a technical description, for example, must actually read a technical description. Finally, each experimental text must be equally "difficult."

In the present experiment, the internal validity of the instruments designed to isolate and measure the effects of rhetorical roles was tested. That is, do the instruments measure what they are designed to measure? Thus the results, as well as the experience administering the experiment, should determine the efficacy of the experimental instruments.

METHOD

Subjects

Twenty-three subjects from a research-and-development firm participated in the experiment. The results from two of the subjects were discarded because of errors in the time measurements, resulting in a sample of twenty-one. Ages of the subjects ranged from 25 to 53 (average of 40), and English was the first language for each. All subjects were notified about the experiment about three weeks before the experiment was conducted. Participation was voluntary, and subjects were informed that they could withdraw from the study at any time.

Materials

Texts. Four texts were selected to represent four genres: reflective essay, short story, news story, and technical description. Brent Staples' "Black Men and Public Space" was selected from an English reader to represent the reflective essay and serve as the control text for the experiment [44]. "Rosary," a short story by Robert Kelly, was selected from *Sudden Fiction* to represent the short story [45]. A straight news story from the *Knoxville News-Sentinel* was modified to represent the news story [46]. Text from pages 30 to 38 of London and Upton's

Photography was used to create the technical description [47]. The four texts are included in Appendix A.

To equalize the mechanical and grammatical characteristics of the four texts, many readability formulas were considered. In the corpus of articles reviewed for this study, the three most popular formulas for predicting readability and equalizing texts are Fry [25] [36] [38]; Flesch [17] [48]; and Dale-Chall [15] [23]. A few researchers incorporated the basic philosophy of readability prediction into homemade formulas [21] [30]. For this study, the Dale-Chall formula was selected as the basis for equalizing the texts [49]. The Dale-Chall formula measures vocabulary difficulty and sentence length to determine a text-difficulty index. In addition to those sentence characteristics, thirteen other characteristics were measured to ensure maximum linguistic matching. Table 1 shows the fifteen characteristics measured on the four different texts.

TABLE 1
CHARACTERISTICS OF EACH GENRE

	Genre			
Text Characteristic	*Fiction*	*News*	*Technical*	*Essay*
1) No. of Words	359	359	359	359
2) No. of Syllables	463	473	466	466
3) No. of Characters	1469	1498	1475	1463
4) No. of Lines	22	22	22	22
5) Vocabulary Difficulty	1405	1376	1399	1397
6) No. of Different Words	174	166	169	207
7) No. of Pronouns	41	27	31	46
8) No. of Dependent Clauses	12	18	13	13
9) No. of Compound Sentences	3	3	3	3
10) No. of Terminal Marks	16	16	16	16
11) No. of Colons	0	0	0	0
12) No. of Commas	18	15	17	19
13) No. of Semicolons	3	3	3	3
14) No. of Hyphens	5	4	4	4
15) No. of Dashes	0	0	0	0

The short story was used as the reference text. The reflective essay, news story, and technical description were revised until they matched as closely as possible the short story in all fifteen characteristics. All four texts were conformed to *The Chicago Manual of Style* to prevent correctness from becoming a nuisance variable [50]. To verify equality of the texts, a Pearson product-moment correlation procedure was conducted to yield a Pearson's correlation coefficient for each pair of texts. As shown in Table 2, the correlation coefficients are near unity, indicating a high degree of correlation.

TABLE 2
PEARSON CORRELATION COEFFICIENT FOR EACH TEXT PAIR

	Essay	Short Story	News Story	Tech Description
Essay	1.00000	0.99985	0.99949	0.99977
Short Story	0.99985	1.00000	0.9997	0.99997
News Story	0.99949	0.9997	1.00000	0.99983
Tech Description	0.99977	0.99997	0.99983	1.00000

The grammatical complexity and length of each text were matched using the text characteristics one through nine. According to linguists, grammar is a system of syntactic, semantic, and phonological rules [26], [51]–[53]. For example, consider the following ungrammatical constructions based upon the sentence "The animals ate the mice," taken from [54].

- Ungrammatical *Syntax*: "Ate animals the mice the." This is an example of improper word order; that is, the typical order for an English declarative sentence is subject–verb–object, and for a noun phrase it is modifier–noun.
- Ungrammatical *Semantics*: "The beds ate the mice." This is an example of improper meaning; that is, beds can't eat.

- Ungrammatical *Phonology*: “The animalés ate the mice.” This is an example of improper pronunciation; that is, English speakers do not pronounce the plural suffix of a noun ending in *l* /és/; they pronounce it /z/.

The readability formula used in this study was used to account for variations in all three constituents of grammar. Characteristics eight and nine accounted for variations in syntax, five through seven accounted for variations in semantics, and two accounted for variations in phonology. Although these are only partial accountings, they are still much more robust accountings than published readability formulas.

Word difficulty was determined by the *Living Word Vocabulary* and its supplement [55]–[56]. Each of the 44,000 words in the *Vocabulary* was included in a 25-year study to determine the percentage of students who can correctly define the word. Students were given three definitions from which to choose, one of which was the correct definition. The study yielded a grade level and percent of students selecting the correct definition for each of the 44,000 words tested. The *Living Word Vocabulary* was selected over word-frequency lists to measure word difficulty because word-frequency lists do not differentiate between multiple meanings. For example, in the *Vocabulary*, the word *point* has eight different entries reflecting eight different meanings. A word-frequency list includes one entry for the word *point.*

To render a word-difficulty measure from a word’s grade level and percent score, Scott’s pi was used. By chance, a person will choose the correct definition of a word from three options thirty-three percent of the time. Scott’s pi takes this chance into account:

$$\pi = \frac{P_o - P_e}{1 - P_e}$$

where Po is the percent of observed correct answers and Pe is the percent of correct answers expected by chance [57, p. 148]. Therefore, the word difficulty of each word was calculated using the following formula:

$$\text{Word Difficulty} = \text{Grade Level} * [(P_O - 0.333)/0.666]$$

The higher the percent score recorded for a word, the lower the word difficulty. All auxiliary words, such as *to* in infinitives and *had* in past perfect tense, were assigned a grade level of 4 and a percent of 67. The aggregate word difficulty of each text was determined by simply summing all word-difficulty calculations.

The readability formula used to equalize texts also measured mechanics. *Mechanics* is the system used to produce visible language, such as printing text on paper or displaying it on a video screen. The mechanics of language include spelling and punctuation rules. Characteristics ten through fifteen accounted for variations in mechanics.

Treatments (Primes). Each experimental text followed a preface that served as an experimental treatment. Each preface contained at least five cues designed to invoke a particular rhetorical role. The genre of the treatment text was mentioned once in the preface title and at least four times in the preface text. Also, a brief description of the content was included in the preface to the treatment text. The three prefaces differ only in the genre cues and the description of the text.

The control text was called a practice trial to prevent the reader from making false assumptions, such as assuming a test of knowledge. For the treatment texts, a promise of some

post-trial activity was required to prevent the accidental induction of a “laboratory reader.” Such a reader may assume a test of knowledge in the absence of any promise. This type of reader is highly improbable in the real world, one who exists only in a laboratory environment and is different from the types of readers the experiment was designed to induce. Therefore, each prime included the promise of a post-trial activity, even though the questionnaire that the subjects received after the trial did not include such activities.

According to the working hypothesis, readers of technical material expect a test of knowledge at some point. They read technical material as a means to an end, whether that end is building skill and knowledge, assembling a bicycle, creating a theory, troubleshooting a malfunctioning computer, studying for a test, or operating machinery, to name a few. Technical readers look for details in a text that are consequential to future activity. For example, the assembly of a bicycle is a successful test of knowledge for someone who reads the assembly instructions. Therefore, the subjects of the experiment who were randomly selected to read the technical description were told that their knowledge of the text would be tested.

Readers of a fictional short story, on the other hand, do not expect a test of knowledge. For them, reading a short story is an end, not a means. The fiction reader satisfies a need to escape, relax, or be entertained. Therefore, the subjects of the experiment who were randomly selected to read the short story were told to expect questions about how entertaining the text was. This promise resolved the ambiguity of no promise, thereby preventing the unintentional induction of a laboratory reader.

Reading news stories is both an end and a means. It is an end in that it satisfies the need for people to be aware of their environment. Thus it satisfies a conscious curiosity about the world. A second-order effect of reading news is that it greases the cogs of social integration. Some

uses-and-gratifications researchers refer to this as simply “talking about media” [58]. According to Noelle-Neumann, “The media provide people with the words and phrases they can use to defend a point of view” [59, p. 173]. Noelle-Neumann calls this phenomenon the “articulation function.” Anyone who has listened to Rush Limbaugh’s talk show will recognize his regurgitating “Ditto Heads” as a textbook example of the articulation function. Therefore, the subjects of the experiment who were randomly selected to read the news story were told that they would be asked to give their opinions about the subject of the news story. The prefaces for each genre, including the control text, are included in Appendix B.

Post-Test Questionnaire. During this preliminary stage of the study, the experimenter wanted to determine and account for nuisance variables that could distort the results of the experiment. Potential nuisance variables, called covariates, were identified as:

1. Control Reading Rate: The amount of time it takes a particular subject to read a text introduced as a practice test.
2. Interest Level: How interesting the subject finds the treatment text (measured on a five-point Likert-type scale).
3. Knowledge of Topic: How much the subject knows about the topic of the treatment text before he or she participates in the experiment (measured on a five-point Likert-type scale).
4. Experience with the Genre: How often the subject reads from a text similar to the treatment text (measured on a five-point Likert-type scale).
5. Age of the Subject.
6. Level of Education.

The first candidate covariate was measured during the practice trial. The other five candidates were measured with a post-trial questionnaire. A sample questionnaire is included in Appendix C. For the readers of the short story, the questionnaire first asked whether the subject had read the short story before. If the subject had not, then prior knowledge of the topic was set at zero. If the subject had read the short story before, then the subject was asked to determine how much he or she remembered about the story.

The experiment was designed to determine the effect of rhetorical role on reading strategy, not the effect on reading ability (comprehension and recall). Reading strategy, operationalized in this experiment as reading speed, should not be confused with reading ability [60]. Therefore, a recall test was not included as part of the post-trial questionnaire.

Apparatus

A 17-inch color computer monitor displayed each text (left-justified) in an area 6 7/8 inches tall by 9 inches wide. End-of-line hyphenation was suppressed. Incident light upon the screen was about 160 lx. Written in BASIC, a computer program running on a Macintosh IIsi computer controlled the presentation of black text (fourteen-point Times Roman) on a white background.

Procedure

Each subject was assigned a random number from 1 to 23 and scheduled to take a trial according to this number (in ascending order). Subjects arriving early or late were separated from other subjects to avoid discussions that may have affected the experiment, such as uncontrolled priming effects. Each subject was escorted individually into an unoccupied office and told to sit before a computer monitor mounted on a desktop. The subject was encouraged to

adjust the seat and video monitor for personal comfort. Each subject was then instructed on how to navigate through the self-administered trial by pressing the space bar on a keyboard. Once the subject indicated that he or she was ready, the experimenter initiated the computer program and exited the office.

At that point, the computer randomly selected one of the three treatments in cycles of three. That is, each of the first three subjects got a different randomly selected number from one through three, as did the next three and so on. In this way, no-shows did not cause any of the three groups to be significantly larger or smaller than another, and the maximum difference between the number of subjects in any two groups would be one. The experimenter did not know which treatment was assigned until the trial was completed.

During each trial, the subject read instructions from the computer monitor. The subject first read an essay, and the time to read the essay was recorded as a control reading rate. Then, after reading a treatment prime, the subject read one of three genres of text: short story, news story, or technical description. One of the three randomly assigned prefaces primed the reader to expect a certain type of reading experience and hypothetically fixed the reader’s rhetorical role.

During each trial, the computer calculated reading times for the first text (the essay) and the treatment text. Subjects were instructed to press the space bar on the keyboard when they started and when they finished reading each text, which prompted the computer to take time readings from the computer’s clock. The difference between the first and second time readings was recorded as the control reading rate. The difference between the third and fourth time readings was recorded as the induced reading rate.

After the trial was over, the subject signaled through an intercom for the experimenter to return to the office. The experimenter obtained the treatment type from the final screen and administered a questionnaire specific to that treatment.

RESULTS

Before conducting an analysis of covariance (ANACOVA), each of the six candidate covariates were correlated with the dependent variable (induced reading rate) using the Pearson product-moment correlation procedure to determine which candidates qualified as covariates. The absolute correlation coefficient should be greater than 0.3 to have any increase in precision over an analysis of variance without covariates [61]. Therefore, the two criteria for qualifying as a covariate are an absolute correlation coefficient greater than 0.3 and a p value of 0.05 or less. As shown in Table 3, only one of the candidate covariates met the criteria for inclusion in the ANACOVA. The control reading rate has a high positive correlation with the induced reading rate ($r = 0.91159$, $p < 0.05$). An experimental design based upon covariation is preferable to blocking only if the correlation coefficient is at least 0.6 [62], [63]. Therefore, the high correlation between the one qualified covariate and induced reading rate validates an experimental design using ANACOVA as the proper approach.

TABLE 3
CORRELATION COEFFICIENTS AND PROBABILITIES FOR THE SIX CANDIDATE COVARIATES

Overall Correlation with IRR

Statistic	CRR	INT	KNO	EXP	AGE	EDU
Rho	0.91159	–0.04252	–0.09158	–0.11107	–0.13111	0.21363
p	0.0001*	0.8548	0.693	0.6317	0.5711	0.3525

*p < 0.05
IRR = Induced Reading Rate, CRR = Control Reading Rate, INT = Interest Level, KNO = Knowledge of Topic, EXP = Experience with the Genre, AGE = Age of the Subject, EDU = Level of Education

As shown in Table 4, the means of the control reading rate demonstrate that the three treatment groups were not equal in beginning reading speed. The treatment means adjusted for the difference in control reading rate were different in the expected direction. However, as shown in Table 5, the differences were slight and insignificant. The mean reading rate for the short story was not significantly lower than the mean rate for the news story (p = 0.38) or for the technical description (p = 0.38).

TABLE 4
MEANS FOR CONTROL READING RATE

Prime	*N*	*Mean*
Short Story	7	126.99
News Story	7	103.04
Tech Desc	7	102.25

TABLE 5
MEANS FOR INDUCED READING RATES AND ONE-TAILED PROBABILITIES FOR MEAN DIFFERENCES BETWEEN SHORT STORY AND NEWS STORY, SHORT STORY AND TECHNICAL DESCRIPTION

Prime	*N*	*Unadj. Mean*	*Adjusted Mean*	*p Value*
Short Story	7	119.45	103.98	
News Story	7	99.38	106.74	0.38
Tech Desc	7	98.48	106.59	0.38

DISCUSSION

Differences in reading speed were in the predicted direction but were not statistically significant. An essential part of building experimental instruments is eliminating plausible rival hypotheses that may explain empirical results. For example, the sample was drawn from a research and development firm where the experimenter worked, a classic convenience sample. Most of the subjects were either engineers or technicians, with presumably an extensive collective experience reading technical documents. Therefore, one would expect the reading

times recorded for the technical description to be faster than had the sample been less technically skewed.

Another plausible rival explanation of the results is that the three treatment texts were not equal. To adequately address the equality of the three texts, a few words must be said about complexity of concept, which the readability matrix does not indicate. Because they are created by the reader, concepts cannot be measured. A reader becomes aware of a concept only after he creates meaning from a text. The textual characteristics we *can* measure—such as structure (syntax) and vocabulary (semantics)—do not tell us anything about intelligibility or complexity of concept. Consider the following sentence from Noam Chomsky, which demonstrates how syntax and semantics function independently from meaning: "Colorless green ideas sleep furiously." This sentence rates a good readability score, yet a reader will fail to yield a concept from it at all. A readability formula will tell us that the sentence is fairly simple, while our sense-making faculty tells us that it is infinitely complex. The syntax of the sentence is impeccable, but like combining water and oil, the general concepts represented by the words cannot be synthesized to create a specific concept.

Post Hoc Analysis

Four of the seven readers of the short story volunteered that the short story was difficult to read and understand. This led the experimenter to doubt the equality of the texts. In a post-experiment questionnaire, the twenty-one subjects were asked to rate the difficulty of the text they read for the experiment on a five-point Likert-type scale, with 0 being the easiest to understand and 4 being the hardest. Seventeen of the twenty-one subjects responded to the questionnaire (short story = 6, news story = 6, technical description = 5). Table 6 shows the

results of an analysis of variance. As expected, the mean perceived level of difficulty for the short story was higher than the mean perceived level of difficulty for both the news story and the technical description. A closer look at the data from the experiment reveals more evidence for text inequality.

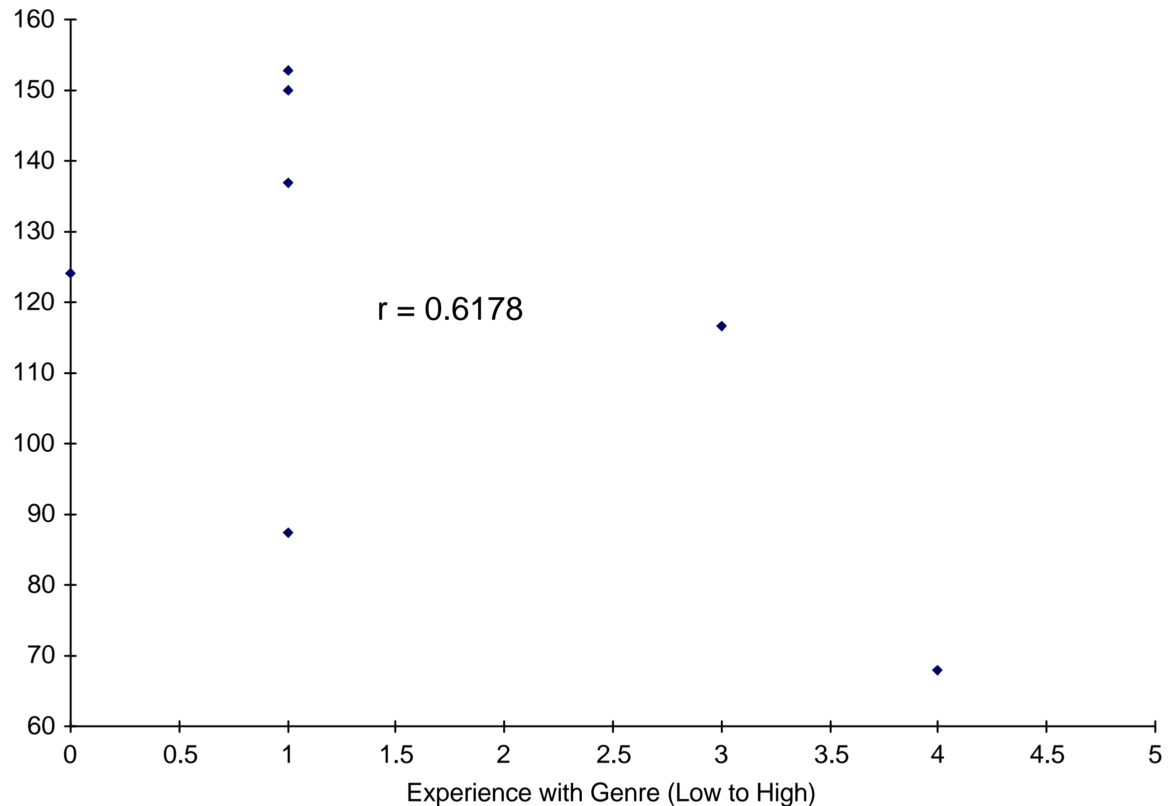
TABLE 6
MEANS FOR PERCEIVED TEXT DIFFICULTY AND ONE-TAILED PROBABILITIES FOR MEAN DIFFERENCES BETWEEN SHORT STORY AND NEWS STORY, SHORT STORY AND TECHNICAL DESCRIPTION

Prime	*N*	*Mean*	*SD*	*p Value*
Short Story	6	1.167	1.167	
News Story	6	2.333	1.211	0.046*
Tech Desc	5	2.600	0.894	0.026*

*$p < 0.05$.

Although the candidate covariate "experience with a genre" was not highly correlated with induced reading rate ($r = -0.111$, $p > 0.6$), it *was* highly correlated with induced reading rate *for the readers of the short story* ($r = -0.6178$, $p = 0.139$). As shown in Figure 2, as experience increases, reading time tends to decrease.

Fig. 2. Correlation between experience with genre and induced reading rate for readers of the short story.



As shown in Table 7, the group of readers who read the short story had much less experience with that genre than the groups who read the news story and the technical description had with those genres (higher numbers mean more experience). This fact, coupled with the perceived difficulty of the text, may account for the longer-than-expected reading times for the readers of the short story. On the other hand, the readers of the technical description had a great deal of experience reading technical documents. This makes sense because, as previously mentioned, the sample was drawn from a research and development firm, where most of the employees are engineers and technicians.

TABLE 7
COMPARISON OF MEAN EXPERIENCE FOR THE THREE TREATMENT GROUPS

Treatment	*Mean Experience*
Short Story	1.57
News Story	4.71
Tech Desc	5.00

Perhaps text difficulty, in the end, cannot be strictly determined from a surface structure. Consider two texts in Table 8. The second text was created from the first by randomly scrambling all the nouns. Table 9 shows how the two texts match up. Even though a Pearson product-moment correlation procedure indicates nearly equal text difficulties (r = 0.99999), it is hard to deny that the differences are immense, with Version 1 representing a reasonably readable text and Version 2 representing gibberish.

TABLE 8
TWO EQUAL TEXTS

Version 1	*Version 2*
We must control light if our eyes, or our cameras, are to form images of objects. You cannot simply place a square piece of film in front of a person and hope that an image of him will appear on the film. The rays of light bouncing off the person would disperse all over the film, which will cause a featureless exposure on the surface of the film rather than the likeness of the person. What one needs to form the likeness of the person on the film is some sort of device that refracts the rays of light from an object onto the film. All lenses do this basic job; they collect light-rays coming from a scene in front of the camera, then project them as an image onto a sheet of film at the back. To render sharp photographs, a lens is thicker in the middle than at the edges.	We must control persons if our likenesses, or our objects, are to form likenesses of persons. You cannot simply place a square exposure of film in front of an image and hope that a device of him will appear on the film. The light of edges bouncing off the job would disperse all over the person, which will cause a featureless middle on the point of the rays rather than the image of the film. What one needs to form the lens of the rays on the objects is some eyes of sort that refracts the film of photographs from a light onto the scene. All backs do this basic camera; they collect pieces coming from a film in front of the light, then project them as a lens onto a camera of point at the sheet. To render sharp light, a film is thicker in the light-rays than at

Lenses can merge many rays of light from a single point and bend them straight toward each other, so that light converges at a focal point.	the light. Surfaces can merge many persons of rays from a single image and bend them straight toward each other, so that film converges at a focal lens.

TABLE 9
COMPARISON OF TEXT CHARACTERISTICS

Text Characteristic	*Version 1*	*Version 2*
No. of Words	179	179
No. of Syllables	231	232
No. of Characters	724	727
No. of Lines	11	11
Vocabulary Difficulty	698	698
No. of Different Words	99	96
No. of Pronouns	11	11
No. of Dependent Clauses	6	6
No. of Compound Sentences	1	1
No. of Terminals	7	7
No. of Colons	0	0
No. of Commas	6	6
No. of Semicolons	1	1
No. of Hyphens	1	1
No. of Dashes	0	0

Although external validity was not a goal for this preliminary phase of the study, internal validity was. The pressing question of the experiment was, “Are the experimental instruments measuring what they are intended to measure?” Therefore, the instruments were put to a more robust test. Fifty-seven college students from the University of Tennessee and Pellissippi State Technical Community College were invited to participate in a within-subjects experiment. Each subject was given all three texts and asked: “On a scale of one to ten, with one representing ‘extremely easy to understand’ and ten representing ‘extremely hard to understand,’ rate the difficulty of the text you just read. (Circle a number from one to ten.)” “Text difficulty” was defined as “how hard is it to understand what the text is talking about.” The order of the three texts were varied and randomly assigned to each subject. Table 10 shows the results of the repeated-measures analysis of variance.

TABLE 10
MEANS FOR PERCEIVED TEXT DIFFICULTY AND TWO-TAILED PROBABILITIES FOR MEAN DIFFERENCES BETWEEN SHORT STORY AND NEWS STORY, SHORT STORY AND TECHNICAL DESCRIPTION

Prime	*N*	*Mean*	*SD*	*p Value*
Short Story	57	4.614	2.085	
News Story	57	3.175	2.346	0.0007*
Tech Desc	57	4.770	2.536	0.7016

*$p < 0.01$.

The results of the analysis indicate a consensus among the college students. They found the news story easier to understand than both the short story and the technical description. As shown in Table 11, the students were about equally divided in comparing the difficulty level of the short story and the technical description. However, more judged the short story more difficult than the news article by a factor of about 2.5.

TABLE 11
COMPARISON OF PERCEIVED TEXT DIFFICULTY BETWEEN SHORT STORY AND NEWS STORY, SHORT STORY AND TECHNICAL DESCRIPTION

Comparison	*Harder Than*	*Easier Than*	*Same As*
Story vs. News	37	15	5
Story vs. Tech	21	25	11

$\chi^2 = 9.164$, $p = 0.01$.

CONCLUSION

The results of the preliminary study reported here indicate that readability formulas cannot be confidently used to equalize texts for a different-samples experiment. To adequately measure sentence difficulty, one would have to discriminate between content and non-content words, abstract and concrete words [64], technical and non-technical words. But even if someday we

innovate an adequate measuring stick for sentence-level difficulty, we will probably never devise an objective method for measuring the difficulty of an entire composition. Because readers are the meaning makers, the difficulty of understanding a composition—that is, text difficulty—is in the eye of the reader, not in the digits of a formula. Meaning is always construed through the prism of a personal psychology [8].

The content of a text may be the most elusive and confounding element of a text, defying quantification altogether [65]. There are literally hundreds of readability formulas [66], and most readability predictions based upon these formulas vary widely from formula to formula [67]. The premise behind most of these formulas is the equation between sentence length and reading difficulty. However, short sentences may be a false characteristic of a readable text. According to Pinker, as "long as the words in a sentence can be immediately grouped into complete phrases, the sentence can be quite complex but still understandable" [51, p. 203]. For example, "The House That Jack Built," a well-known nursery rhyme, concludes with a 71-word sentence with 13 relative clauses [68]. Although this nursery rhyme would rate a low readability score by most readability formulas, it nevertheless remains in the canon of pre-school treasures.

McEneaney suggests that predicting text difficulty may require a neural network, which is "an approach to computing that attempts to make computers more brain-like in the way they operate and are constructed" [69, p. 81]. But whose brain will this network emulate? Whose judgment will the computer bring to bear upon a text? Objectively predicting text difficulty is likely forever insurmountable. Perhaps the only reliable way to precisely match texts for a different-samples experiment is to use the same text in each treatment group, to find a text that can serve all treatment groups without denying the reader's expectations. Although rare, this technique is not without its supporters [39].

The results of an experiment to determine the effect of rhetorical roles on reading strategy will apply to many writing professions and fields of inquiry. If technical readers are shown to be more careful readers than other types of readers, science and technical communicators must compose to a higher standard of clarity than they are accustomed. Prescriptions for English composition have been passed to science and technical communicators through governmental institutions, with influence from enfranchised universities and big business [70]. These prescriptions are based largely upon Latin grammar and in no way upon the results of reading research.

Assuming that the characteristics of a text wholly determine the attentiveness of the reader, writers of technical and science prose may mistakenly believe that the ordinary application of prescriptive grammar and mechanics will yield a text worthy of a reader's strict scrutiny and expectations of difficulty. If research results show that high reader expectations raise the bar for technical communicators and science journalists, grammar handbooks and style manuals may need to be revised for those professional writers based upon the way technical readers read technical texts.

Teachers of technical and science communication should consider incorporating the findings of reading research into their courses. Teaching future technical writers and science journalists to reflect upon the behavior of intended audiences will help produce more thoughtful, effective communicators. They will know that their readers will expect difficulty and slow down, as they have been taught to do (e.g., [35]). The irony here is that while these readers may slow down to understand more, studies indicate that recall and comprehension decrease as reading speed decreases [21], [36], [71]. This counterintuitive impediment doubles a communicator's challenge: to craft prose that will both withstand the terrible scrutiny of the technical reader and

encourage swift assimilation of words, all without condescending to the reader. Confirming that technical readers unconsciously adopt a demanding persona will be the first step in surmounting that challenge.

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APPENDIX A: FOUR TEXTS USED IN THE EXPERIMENT

Essay

The first person was a white woman, well-dressed and perhaps in her late twenties, casting back a worried glance. I came upon her late one night on a deserted street in a rich neighborhood of an otherwise poor section of the city. As I swung onto the street behind her, there seemed to be a wide gap between us; this was not so. To her, the young black man was too close. I was broad, over six feet tall, wearing a beard and wild hair, and had both hands shoved into the pockets of a bulky army jacket. After a few more quick glances, she picked up her pace and was soon running away in fright. Within seconds she vanished into a cross-street. That was more than ten years ago, when I was twenty-two years old, a college student who had just arrived in a new town. My close encounter with that scared woman was the first time I began to know my ability to alter public space in ugly ways. It was clear that she thought herself the target of a robber or a rapist or worse, although I was stalking sleep, not people, during a bout of insomnia. As a softy who is hardly able to take a knife to raw chicken, I was shocked, embarrassed, and dismayed all at once. Her flight made me feel like an accomplice in crime; it also made it clear that I looked like the muggers who seeped into the city from sprawling ghettos. That first encounter and those that did follow signified that the distance between nighttime walkers and me was a vast gulf. I soon knew that being thought of as a danger is a hazard in itself; I only needed to turn a corner into a dicey situation or pass some armed person in a dark hall or make an errant move after being pulled over by a policeman. Where fear and weapons meet, there is always the chance of death. In that first year, my first year away from my hometown, I became familiar with the language of fear spoken by the night-people.

Short Story

Here is a man walking on a road under the half-moon. The trees are tall and well-furred; the light is little. In his left hand, sometimes swinging at his side and sometimes held lightly poised over his heart, he counts the crystal beads of a rosary. After a quarter of a mile of dark road, he passes a large building of some hard-to-determine kind. In a ground-floor wing, one room is brightly lit; near a window sits a woman with glossy black hair, bent to some papers. The man admires the profile, the hair, the air of industriousness. He likes people who work hard. He walks on, dismissing the notion of rapping on window or door and chatting with the woman. It must be frightening to be a woman alone in a building at night, when the building itself is alone in the countryside, nothing for half a mile round except trees and a man with crystal beads in his hand and the young deer he had seen cross the road in front of him a few minutes back. She would be scared if I knocked, he thought, and walked on. Now it may be that before the man had drawn abreast of the window, the woman had seen him coming, had looked out casually from a darkened window in another room, and had seen this man stepping up the intermittently moonlit road. It may be that the gleam of crystal in his hand seemed to her the gleam of moon on dagger. It may be that she longed for this silent shadowy assassin to come to destroy her, to rescue her from hard work or loneliness or her glossy hair. It may be that she posed at the lighted window to woo his attention, and long after he passed still hoped he might be lurking in the rhododendrons. Perhaps ten minutes later she bravely, desperately stepped out of the unbolted door and stood on the lawn and saw no one but the same deer browsing under the fruit trees. Or perhaps it was not the same; who can tell one animal from another?

News Article

A year and a half after the approval of a clot-busting drug, surveys show that many doctors still fear using the drug as a first care for strokes because it may have unsafe side-effects. The slow acceptance of the drug was a major topic at a recent meeting, which was held last week. Until two years ago, there was no therapy for strokes; many hospitals did not even think that strokes were crises because there was not much that they could do. In June, the government approved the drug for strokes. Within three hours of a stroke, the drug can dislodge a clot that hinders blood from flowing to the brain. Studies show that the drug can reduce the risk of paralysis and other problems by up to forty percent. One study shows that the effect of the drug persists up to a year after treatment. The drug is now used for heart attacks; doctors have used it on more than a million people in the past ten years. Still, the drug is harder to dispense to stroke victims; doctors must examine them to make sure that their strokes have not been caused by bleeding in the head rather than a clot. If a doctor gives the drug to such a patient, it can harm or even kill the patient. For this reason, some doctors at the meeting said that they are afraid to try the drug. Doctors who dispense the drug to heart-attack victims may not be willing to try it for a stroke without the advice of a stroke expert. Even if an expert is at hand, he or she may not know enough about this drug to give good advice. Doctors at the meeting said that, in time, emergency-room doctors will be trained to decide when to dispense the drug without the advice of a stroke expert. Even if doctors are willing to dispense the drug, most patients will not get it because they do not reach a hospital in time. Also, a doctor may not dispense the drug because other drugs, such as blood thinners, may make it a risky treatment.

Technical Description

We must control light if our eyes, or our cameras, are to form images of objects. You cannot simply place a square piece of film in front of a person and hope that an image of him will appear on the film. The rays of light bouncing off the person would disperse all over the film, which will cause a featureless exposure on the surface of the film rather than the likeness of the person. What one needs to form the likeness of the person on the film is some sort of device that refracts the rays of light from an object onto the film. All lenses do this basic job; they collect light-rays coming from a scene in front of the camera, then project them as an image onto a sheet of film at the back. To render sharp photographs, a lens is thicker in the middle than at the edges. Lenses can merge many rays of light from a single point and bend them straight toward each other, so that light converges at a focal point. How does the lens bend light? When light-rays pass from one substance, such as air, to another, such as water, the rays of light refract. The shape of a spoon in a half-glass of liquid is one example; the stem appears to be disjoined. Even with the best available camera lens, you will not be pleased with the photographs that you take if you do not hold the camera still. Too much camera vibration will cause the image to blur on the film; increasing the time that the light strikes the film will also increase the chance that the lens will form a blurry picture. You can adjust the amount of time that the light strikes the film. In a well-lit scene, you do not require much time, although in a poorly lit scene, you will need more time. In that case, you should keep the camera as steady as possible by bracing both arms against your torso, holding your breath, and grasping the camera firmly. You can also use a sturdy tripod to steady the camera.

APPENDIX B: PREFACES

Preface to the Reflective Essay (Control Text)

Thank you for participating in this reading experiment. Please relax, adjust the position of this screen for best viewing, and lightly rest your index finger on the space bar. When you are ready to begin reading the next screen, press the space bar.

On the next screen, you will see an essay by an African American about his experience walking the streets of Chicago. To practice reading text on this computer, please read the next screen at a comfortable pace. When you press the space bar to display the text, an apple will appear on the screen. Look at the apple. It locates the beginning of the text. After a few seconds, the apple will disappear and the text will appear. Please start reading as soon as the text appears on the screen.

As soon as you have finished reading the last word, immediately press the space bar to proceed to the next screen.

Prime for a Short Story

Reading a Short Story

Please read the short story on the next screen. The short story is about a near encounter between a man and a woman told from the man's point of view. When you press the space bar to display the short story, an apple will appear on the screen. Look at the apple. It locates the beginning of the text. After a few seconds, the apple will disappear and the short story will appear. Please start reading as soon as the text appears on the screen. As soon as you have finished reading the last word, immediately press the space bar to proceed to the next screen.

After you read the short story, you will be asked to rate its quality, such as how entertaining you consider it to be.

Please press the space bar when you are ready to read the short story, and remember to press the space bar immediately after you read the last word of the text on the next screen.

Prime for a News Story

Reading a News Story

Please read the news story on the next screen. The news story reports the reaction of the medical community to a drug approved for stroke victims. When you press the space bar to display the news story, an apple will appear on the screen. Look at the apple. It locates the beginning of the text. After a few seconds, the apple will disappear and the news story will appear. Please start reading as soon as the text appears on the screen. As soon as you have finished reading the last word, immediately press the space bar to proceed to the next screen.

After you read the news story, you will be asked to express your opinion about the new drug.

Please press the space bar when you are ready to read the news story, and remember to press the space bar immediately after you read the last word of the text on the next screen.

Prime for a Technical Description

Reading a Technical Description

Please read the technical description on the next screen. The technical description explains how a camera lens controls light. When you press the space bar to display the technical description, an apple will appear on the screen. Look at the apple. It locates the beginning of the text. After a few seconds, the apple will disappear and the technical description will appear. Please start reading as soon as the text appears on the screen. As soon as you have finished reading the last word, immediately press the space bar to proceed to the next screen.

After you read the technical description, you will be tested on how camera lenses control light.

Please press the space bar when you are ready to read the technical description, and remember to press the space bar immediately after you read the last word of the text on the next screen.

Appendix C: Example of Post-Test Questionnaire (News Story)

Questionnaire Instructions: To ensure anonymity, please do not write your name anywhere on this form. Circle the appropriate answer to each question. Give the completed survey to the proctor.

- Question 1: How interesting did you find the news story about the stroke drug? (Circle one)

  0 Not at all 1 Somewhat 2 Moderately 3 Very 4 Extremely

- Question 2: How knowledgeable were you about strokes and stroke drugs *before* you read the news story? (Circle one)

  0 Not at all 1 Somewhat 2 Moderately 3 Very 4 Extremely

- Question 3: Some people read newspapers a lot, and others don't have time to read newspapers at all. Averaged over the past two years, how often do you read from news articles in a newspaper? (Circle one)

  0 Never 1 A few times over two years 2 A few times per year 3 Once a month

  4 A few times per month 5 A few times per week 6 Every day

- Question 4: Is English your first language? (Circle one) Y N

- Question 5: What is your age? ___________

- Question 6: How many years of formal education do you have? Include the number of years in grammar school, high school, and higher education. For example, someone with a high school education and an associate's degree would enter 14 (12 for high school and 2 for college).

  Years of Education ___________