

Men and Women Read News Differently

The Effects of Story Structure on the Cognitive Processing of Text

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Abstract. This study explored how the structure of written news affects men and women differently in terms of cognition. In a 2 (Structure) $\times$ 2 (Story) $\times$ 2 (Sex) mixed design, participants read two inverted pyramid and two chronological news stories, each on a different topic. Dependent measures included secondary task reaction times (STRTs), cued recall, recognition accuracy, and text comprehension. Women had slower reaction times than men across stories, but a significant interaction showed their use of cognitive resources was less affected by variations in story structure. These results are discussed in the context of a comprehensibility interpretation of the STRT measure. The findings suggest that the common use of the inverted pyramid structure, which has been criticized as difficult to comprehend, may not explain the decrease in female news readers.

Keywords: cognitive processing, reading, sex differences, news, STRT, limited capacity model of motivated mediated message processing

Introduction

An interesting fact that has emerged in readership literature is the so-called “gender gap,” which refers to the fact that fewer women than men read news (The News Gender Gap, 2004, July 9). The gender gap phenomenon has come into play only in the last 30 years, and it is present despite significant evidence that women have an inherent advantage in language processing, including reading. It would be easy to dismiss this shift as another symptom of the time-limited lifestyle that many women experience in juggling careers and family. But various studies and data suggest a need for alternative explanations. Women do care about news: According to one study, more women than men watch television news (The News Gender Gap, 2004, July 9). But they seem to dislike print news: At least one study (McGrath, 1993) speculates that they see newspapers as carriers of a “male personality” (p. 103) and irrelevant to their lives. While anecdotal, such accounts raise the question of whether women are less likely to read news because it fails to meet some of their inherent reading preferences. This study explores whether the inverted pyramid, the news writing standard of American journalism, is less suitable to female readers. The evidence is against the inverted pyramid, which places the most information at the beginning, followed by the second most important element, and so forth. At least two experiments have shown that rewriting news elements into chronological order seems to improve memory for content (Lang, 1989) and reading enjoyment (American Society of Newspa-

per Editors, 1993). Other research suggests readers understand complex science stories better when they are written in an explanatory, structure-building model rather than in the inverted pyramid (Yaros, 2006).

Informational text lacking context and presenting contrasting points of view (such as the inverted pyramid) has been viewed as a masculine style of communication (Wood, 2007). By contrast, a feminine style of communication is more likely to be built around examples, contextual details, tentativeness, and avoidance of conflict (Wood, 2007). In journalism research, the only support for a connection between sex and linguistic style comes from Ruffner and Burgoon (1981), who found female journalists use longer sentences, more words, and more modification (adjectives and adverbs) than male journalists. This study extends these ideas to the study of story structures in news. We derive hypotheses from a cognitive theoretical framework and various studies about biological differences in linguistic performance.

Sex Differences in Reading

Why do fewer women than men read news? Is it possible that story structure acts as a moderator in the relationship between sex and reading ability? There are virtually no media psychology studies addressing the issue, although some sociological explanations have been suggested. The topic is important for the news industry, which is experiencing a major shift

in news delivery channels combined with increasing mistrust in media (Jones, 2004). But the question is also of theoretical significance, because it may indicate a potential limitation to the well-supported finding that women have a biological advantage in language processing.

Despite the use of the term gender gap, the focus of this study is really on sex differences in reading. "Gender" is often used synonymously with biological sex, but this study views gender as "a social, symbolic construction that expresses the meanings a society confers on biological sex" (Wood, 2007, p. 318), while "sex" is a dichotomous variable with two levels, male and female.

In 1970, 78% of adult women and 77% of adult men were likely to read a daily newspaper; 20 years later, only 64.5% of men and 60.5% of women read a daily newspaper (Fitzgerald, 1994). In 2004, the gender gap was still present: About 51% of men and 46% of women read a daily paper, according to data from the Newspaper Association of America. The difference is especially striking for the 25–34 age group: About 42% of men and 30% of women in that category read daily newspapers (Mitchell, 2004). *USA Today* has reported yet more alarming numbers: In 2004, 47% of men and 37% of women read newspapers (The News Gender Gap, 2004, July 9).

A similar gender gap exists for online news. The Pew Internet & American Life Project (Usage Over Time, 2009) reports that 35% of women and 42% of men responded "yes" when asked whether they got news online yesterday. Shaw and Gant (2002) observe that while the gender gap in Internet access disappeared in the early 2000s, women have continued to use Internet less frequently than men and more often for interpersonal communication than for information and entertainment. De Wahl, Schonbach, and Lauf (2005) note similar differences in the Netherlands, where online newspaper readers in 2002 were "mainly younger, highly educated and male" (p. 61). Reading newspapers online correlated positively with reading other news sites for both men and women, but correlated negatively with TV watching only for men (De Wahl et al., 2005).

News Preferences

Research suggests that male and female readers approach news content differently. For example, men and women read some of the same news but in different combinations (Weaver & Mauro, 1978). Women also evaluate crime stories as more disturbing than do men (Ketterer, 2002). In processing broadcast news, women process pleasant stories more effectively than they process unpleasant stories; they are also drawn to stimuli that are moderately arousing as long as the stories deal with pleasant topics, while they tend to avoid unpleasant ones (Grabe & Kamhawi, 2006; Kamhawi & Grabe, 2008). By contrast, men are drawn to unpleasant stories more than to pleasant stories (Kamhawi & Grabe, 2008). Given the abundance of negatively framed news, a phenomenon Shoemaker (1996) links to a surveillance function, this may offer another

explanation for why women are less avid news readers than men. Strong female readership has been traced to local news, especially when the community exhibits "emotional consensus" (McGrath, 1993, p. 101).

The gender gap may reflect a shortage of news topics considered to be appealing to women, such as human-interest stories, culture, social policy, children, and education (Van Zoonen, 1998). Based on market research and comments from readers, some newspaper editors have tried to add more female sources and strengthen the coverage of education, health, homemaking, and fashion, which are topics branded as "content for women" (Armstrong, 2006, pp. 447–448). Still, there is a "vast difference" (Armstrong, 2006, p. 458) in editors' and publishers' opinions and findings about what topics women want or do not want to read. An early readership study suggests it may be involvement in the workforce and not a sex difference that determines topic preferences; specifically, working women were more interested in consumer safety, health, environment, food, and wars; housewives preferred to read about crime, economics and science (Einsidel & Tully, 1981).

Based on this research, it appears that issues of topic preferences are not easily narrowed or generalizable to all women, which is why this study focuses on the less explored area of news writing standards and their effect on female readers. The gender gap in news readership is particularly perplexing given research suggesting that women are better readers than men, regardless of genre or story structure. This advantage is outlined in the next section, which sets the stage for the hypotheses derived from the theoretical framework.

Language Abilities

Women's relative strength in verbal tasks holds across cultures: In a study of 199,000 adolescents in 43 countries, including the United States, Chiu and McBride-Chang (2006) found girls outscored their male classmates on reading achievement in every country, although 42% of the effect was mediated by reading enjoyment. Hedges and Nowell (1995), analyzing six large datasets, found American females were slightly better than males in reading comprehension (mean differences, Cohen's *d*, of about 0.1–0.2) and substantially better in writing skills (mean difference of about 0.6). About 7 out of 10 girls outperform the average boy in writing performance, and about 3 out of 5 girls outperform the average boy in reading skills. But that does not imply that girls are better at all tasks involving language. For instance, boys show better achievement in solving word problems (Geary, 1998), whereas women outperform men at immediate and delayed verbal recall of text, including semantic clustering (Kramer, Delis, & Daniel, 2006) and overall confidence of verbal skills (Ackerman, Bowen, Beier, & Kanfer, 2001).

Biologically speaking, women's advantage in reading might result from the fact that most women process language in both hemispheres, while most men process lan-

guage predominantly in the left hemisphere (e.g., Pizzamiglio, Mammucari, & Razzano, 1985; Shaywitz & Shaywitz, 1995; Shaywitz, 1996). Another hypothesis is that women have a higher density of neurons in the primary site for speech processing (Witelson, Glezer, & Kigar, 1995), increased gray matter volume in areas hypothesized to be involved in language processing (Good et al., 2001), and larger subregions of the corpus callosum, which connects the brain hemispheres (Allen, Richey, Chai, & Gorski, 1991; McGlone, 1980). The following section aims to place these differences within the context of a theoretical framework of cognitive processing.

Theoretical Framework and Hypotheses

This study is grounded in the limited capacity model of motivated mediated message processing (Lang, 2000, 2006), which is summarized in the immediately following subsection; and the construction-integration model of text comprehension (Kintsch, 1988), outlined in detail later in the study as the framework for Hypothesis 5. Both models, albeit different in many respects, take into account the limited processing capacity of the human brain. Reading and understanding news depends on attention and memory, both of which are subject to capacity limitations. Cognitive performance suffers when attention is divided (e.g., Cowan et al., 2005; Sauls & Cowan, 2007), a relationship that lies at the core of the secondary task approach to measuring cognitive capacity. The more cognitive resources a primary task uses, the slower the reaction to a secondary task (Lang, Bradley, Park, Shjin, & Chung, 2006).

LC4MP

Much of this literature is framed by the limited capacity model of motivated mediated message processing (LC4MP), which serves as the foundation for comparing inverted pyramid and chronology (Lang, 2000, 2006). This model applies much of the psychological research on attention and memory limitations to the processing of media messages, specifically broadcast ones. The model includes three stages of cognitive processing: encoding, storage, and retrieval, which are “continuous and iterative” and for the most part occur simultaneously. The allocation of both controlled (goal-directed, intentional, conscious) and automatic (unintentional, unconscious) resources eventually determines the extent to which a message is comprehended and may lead to some learning.

Lang (2000, 2006) specifically distinguishes between automatic and controlled processes in the encoding stage, when information is perceived. This stage, when sensory input is taken in, is assumed to have priority in the processing of broadcast messages due to the lack of control over pace. Storage refers to the keeping of selected bits of the

sensory input in sensory stores of working memory. Associations spring between new and old mental representations, and information bits that fit in with activated memory networks make it into storage. Retrieval refers to searching associative memory networks for relevant knowledge needed to comprehend and store new information. Because Lang (2000, 2006) assumes that resources are allocated from a single pool, available resources can be allocated to one process or distributed among the three. Messages may not be thoroughly processed either because the recipient chooses to allocate fewer resources than necessary or because a message requires more than the available resources.

The LC4MP discusses these subprocesses in the context of television viewing, but not reading, which is largely unexplored in media psychology research. Yet the LC4MP is relevant to cognitive processing of text because “its roots lie in the information-processing tradition of cognitive psychology” (Lang, 2000, p. 46). The model incorporates earlier theories on attention and memory used in educational psychology (e.g., Mayer & Moreno, 1998) and reading research (e.g., Haarmann, Davelaar, & Usher, 2003). In reading, much of the encoding likely happens through automatic processes, as shown by the classic Stroop color-word task, in which participants tend to read words referring to colors faster than they can name the color of the ink in which the words are presented (Stroop, 1935). Whatever is missed in these automatic processes that depends on reading skills and experience can be made up through controlled processes such as careful rereading.

In reading, it is logical to assume that what Lang (2000, 2006) refers to as the storage phase (which includes the springing of associations between new and old mental representations) has priority in the processing of the message. This is indirectly supported by the comprehension-integration model (Kintsch, 1988; Kintsch & van Dijk, 1978), which places an emphasis on drawing inferences as the most important part of reading. It should be noted that retrieval, the activation of old mental representations (previous knowledge in the comprehension-integration model), is needed before integration of new information can occur. The next section uses the LC4MP to lay the foundation for a hypothesis specific to the use of men’s and women’s cognitive resources in processing text.

Available Resources During Reading

One way to explore how reading different story structures puts a load on human cognition is by looking at available resources, defined as resources allocated to a task minus resources required by it (Lang et al., 2006). A typical measure of available resources is secondary task reaction time (STRT). People watching a message (primary task) are asked to press a button when they hear an audio tone (secondary task). The logic is that primary tasks that use of a lot of cognitive capacity would lead to slower reaction to the secondary task.

STRT has been used, albeit seldom, in text comprehension studies. Britton, Graesser, Glynn, Hamilton, and Penland (1983) measured cognitive capacity with auditory and tactile probes during reading of text in six experiments. They compared narratives and expository texts (loosely similar to chronological and inverted pyramid structures in journalism). The results were somewhat counterintuitive. Slower reaction times emerged for narratives (generally presumed to be easier to process) than for expository texts. Britton et al. (1983) argued that slower STRTs reflect the fact that readers are more absorbed. In other words, "narrative passages produce more meaning because schemata for narrative texts are more familiar, more frequently encountered, and easier to comprehend than schemata for expository texts" (Britton et al., 1983, p. 39); when more meaning is produced, more cognitive capacity is filled. This is consistent with earlier studies showing that readers were slower to respond to a secondary task when reading easy-to-comprehend text (as measured by a Cloze test, which asks participants to fill in missing words as a gauge of their understanding) than when reading a more difficult text (Britton, Holdredge, Curry, & Westbrook, 1979; Britton, Westbrook, & Holdredge, 1978).

Recall rates were similar for both easy and difficult passages, suggesting only that both had been read (Britton et al., 1978). But total cognitive capacity usage, a concept coined by Britton's group and calculated by multiplying the number of seconds it took to read a passage by the average reaction time in milliseconds, was greater for difficult than for easy passages. Britton et al. (1978) argued that "frequent breakdowns" (p. 589) in short-term memory, reflecting encounters with unfamiliar words or complex grammar, temporarily empty working memory during the reading of difficult passages, freeing up capacity for the secondary task.

Text generating more "meaning conveyed by the integrated sentences of the text as a unit" (Britton et al., 1979, p. 263) also elicited slower STRTs than text consisting of sentences meaningful on their own but unrelated to their neighbors. Readers' STRTs were slower if they had background knowledge in the topic of the texts they were reading than for texts on relatively unfamiliar topics (Britton & Tesser, 1982); during reading of texts about people than about inanimate objects (Britton et al., 1983); and during reading of children's literature than adult literature (Britton et al., 1983). In all these studies, Britton's group interpreted slower reaction times as an indication that easier and more engaging texts fill more cognitive capacity.

This approach is very different from Lang et al.'s (2006) paradigm, which views STRT as a measure of resources (available or remaining) at encoding and is significantly influenced by features eliciting orienting responses, such as scene changes. From the standpoint of the LC4MP, it is likely that STRTs in the above-mentioned studies (Britton & Tesser, 1982; Britton et al., 1978, 1979, 1983) did not measure encoding of the messages because they were in channels (auditory and tactile) different from the track in which text messages are perceived (visual). Rather, Brit-

ton's probes likely measured availability of capacity not filled by storage and retrieval, which is related to the argument that STRTs reflect construction of new associations and access to long-term memory. For example, sentences judged "important in the content structure of the passage" (Britton, Muth, & Glynn, 1986, p. 482) elicit slower reaction times than other sentences, and experts reading on their topic of expertise are likely to activate much prior knowledge and use a large amount of cognitive capacity (indicated by slower STRTs) while processing information they understand well (Britton & Tesser, 1982).

In what they refer to as the comprehensibility hypothesis, Britton et al. (1983) suggest that "cognitive capacity is filled during reading by the meaning that is produced in the reader's cognitive system" (p. 41). Meaning is defined as "large amount of cognitive content besides the text itself" (Britton et al., 1983, p. 41), including memories, schemata, affect, and cognitive elaborations. These findings are consistent with research showing that folktales (loosely similar to chronology as defined here) are read more quickly than information-conveying structures, such as encyclopedia articles (Graesser, Golding, & Long, 1991).

Although it is difficult to distinguish between resources required and allocated for text messages, it will be assumed that chronological stories, which introduce little new information at first and are hypothesized to be the simpler messages, require the allocation and thus use of fewer resources than inverted pyramid stories. This would result in slower STRTs (as a measure of available resources in the LC4MP paradigm), which is consistent with Britton's results.

The sex differences in language processing outlined earlier suggest that women, being more proficient readers with better comprehension and memory, are more likely to be engaged with meaning construction during reading. In line with the comprehensibility hypothesis (Britton et al., 1983) mentioned earlier, this can be expressed in the following way:

H1: For all stories, women on average will show slower secondary task reaction times (STRTs) than men.

A view of the inverted pyramid as a masculine style of communication, discussed earlier, does not necessarily contradict the massive literature on an overall female advantage in reading. Rather, story structure can be seen as a specifying limitation to this general advantage. The following hypothesis is based on the logical assumption that women will display more relative ease of reading chronological stories than men, and more relative difficulty of reading inverted pyramid stories than men:

H2: There will be an interaction between sex and story structure, such that the mean secondary task reaction time (STRT) for women during reading of chronological stories will be greater (slower) than the mean STRT for women during reading of inverted pyramid stories and the mean STRTs for men during both kinds of stories.

As mentioned earlier, Britton et al. (1978) used cognitive capacity usage, calculated by multiplying STRT for each passage (in milliseconds) by the reading time for the same passage (in seconds). The measure “weights the average capacity usage by the span of time over which that capacity is being used” (Britton et al., 1978, p. 584) and is larger for more complex stories. From the standpoint of the LC4MP, that measure reflects resources available (indexed by STRT) by the time it took to cycle through the encoding, storage, and retrieval subprocesses for a given paragraph. In an attempt to clarify H1, the following research question emerged:

RQ1: Will there be an interaction between sex and story structure in total cognitive capacity usage?

Because inverted pyramid stories may lead to disengagement and present a cognitive challenge, they can also be expected to lead to less knowledge gain and poorer memory. In the context of TV news, stories written in “broadcast” style (presenting what is new first, followed by what caused the change and the consequences of the change) force readers to constantly access long-term memory (Lang, 1989). Specific hypotheses about sex differences with respect to reading news are derived in the following section.

Memory and Comprehension

Two measures for assessing knowledge gain are recognition memory and cued recall, negatively affected under cognitive overload (e.g., Lang, Bolls, Potter, & Kawahara, 1999). Recognition, the most sensitive memory test, has been used as a measure of message encoding performance (Lang, 2000, 2006); and cued recall has been used to index storage (Lang, 2000, 2006). Based on the literature, women can be expected to display more relative ease of reading (and hence remembering) chronological stories than men, and more relative difficulty of reading (and hence remembering) inverted pyramid stories than men. Based on this, the following hypotheses are proposed:

H3: There will be an interaction between sex and structure, such that women’s mean recognition for chronological stories will be greater than women’s mean recognition for inverted pyramid stories and all of the recognition means for men.

H4: There will be an interaction between sex and structure, such that women’s mean cued recall for chronological stories will be greater than women’s mean cued recall for inverted pyramid stories and all of the cued recall means for men.

How well people remember a text relates to how well they understand it. The next section explores the construction-integration model (Kintsch & van Dijk, 1978), a convenient

framework for testing comprehension because of similarities with the LC4MP and grounding in cognitive research.

Construction-Integration Model (CI)

Kintsch and van Dijk’s (1978) model presumes comprehension, a “cyclical process constrained by limitations of working memory” (p. 363), occurs in three stages. First, text elements are organized into a coherent whole; then, the gist is subtracted; and finally, new texts are generated from “memorial consequences” (Kintsch & van Dijk, p. 363). Readers make many parallel inferences, some of which become deactivated during reading and integration. For best comprehension and long-term memory, the reader must be able to derive relevant “macropropositions” (Kintsch & van Dijk, p. 372) that place current events in context.

The CI suggests inverted pyramid stories offer readers a ready macroproposition (derived by the writer), which should make comprehension easier. On the other hand, readers of chronological stories have the chance to derive their own macropropositions as they progress through the unfolding of events. The LC4MP model (Lang, 2000, 2006) suggests that (at least in a broadcast context) a chronological presentation would leave most of the readers’ existing cognitive resources available for encoding and storage; fewer resources would be spent on retrieval, which is needed to facilitate storage.

Sentence Verification Technique (SVT)

A measure specific to comprehension is the Sentence Verification Technique (SVT), which requires participants to decide whether a test sentence means the same as a sentence in the original text. It is grounded in the CI model and forces one to engage in interpretation rather than just recollection (Royer, 2001; Royer, Hastings, & Hook, 1979). Based on literature favoring chronological structure and women’s assumed preference for chronological stories, the following hypothesis emerges:

H5: There will be an interaction between sex and structure, such that women’s mean SVT score for chronological stories will be greater than women’s mean SVT score for inverted pyramid stories and all of the SVT means for men.

Method

The hypotheses were tested through an experiment in which participants read stories varying between inverted pyramid and chronological structure, and completed memory measures. The availability of cognitive resources was measured through STRT, with audio probes occurring randomly during reading.

The experiment used a 2 (Structure) $\times$ 2 (Story) $\times$ 2 (Sex) mixed design. Structure was a within-subjects factor with two levels: inverted pyramid and chronological. Story was a repetition factor within structure, meaning that each participant read two inverted pyramid stories and two chronological stories; Sex was a between-subjects factor. An inverted pyramid and a chronological version were written for each of four stories, with the possible combinations of Writing style and Story counterbalanced so that each participant read two inverted pyramid and two chronological stories.

Participants

There were 112 participants (46 men and 66 women), recruited from two different Midwestern universities. Participants received either extra course credit or \$10 for participation in the study. In the first group of 58 participants, 88% were undergraduate students (likely aged 18 to 23) at a large Midwestern university. Some received extra credit for participation in the study, whereas others chose to receive \$10 for participation. The second group consisted of 54 participants, all of whom undergraduate students (likely aged 18 to 23, with the exception of one nontraditional student) at a middle-size Midwestern university, all of whom received extra credit.

Independent Variables

The main independent variable was story structure, operationalized in two levels: chronology and inverted pyramid. A chronological story presents most of the facts in the temporal order in which they occurred. By contrast, an inverted pyramid story places the most important news at the top, followed by the next most important element, and so on. Since there can be variations to the inverted pyramid structure (Gans, 1979), stimuli included only stories with 5-W leads (answering the questions, *Who? What? Where? When? Why?*), consistent with Schramm's (1947) definition of inverted pyramid.

Stimuli

The stories were taken from online news sites and abridged to 300 words each. A pretest, which asked 11 graduate students to rate stories on the degree to which they perceived their fit with a chronological or inverted pyramid form, suggested some of the original stimuli included elements of both (as in the commonly used "news narrative" form). Three newspaper editors with significant journalistic experience were asked to assess the stimuli. Once agreement was achieved on creating four "pure" inverted pyramid stories of 300 words each, chronological versions were created by simply reshuffling the paragraphs and making minor changes in wording to add necessary transitions, an ap-

proach similar to Lang's (1989) for broadcast news stories. The chronologically structured story was not edited to fit newspaper routines (for example, there was no journalistic "hook" in the lead).

The manipulation accounted for a total of eight messages. The two versions for each story were presented with identical hard-news headlines and decks conveying the gist. The two versions of each story had approximately the same Flesh ease-of-reading scores (a measure of reading difficulty that is available through a function of Microsoft Word), contained equal number of sentences and concepts, and differed only in the news-writing style.

Dependent Variables

Secondary Task Reaction Times (STRTs)

As outlined by Lang et al. (2006), an audio STRT probe (250 ms, 1,000 Hz) was inserted at three randomly selected points in each message, with one probe occurring in each third of the messages. While reading news stories (primary task), participants were asked to click "Enter" as soon as they heard an auditory signal (secondary task). To create markers for the probes, each story was presented in three installments, one installment per screen. Participants were asked to press a button to move on to the next installment. The probes were inserted at random times, selected through a random number generator. To ensure consistency within each condition, the probes occurred at the same times for each specific version (e.g., a tone always occurred at the sixth second of the second chunk of the chronological version of Article 2). To ensure the validity of the STRT measure, the random selection of the probe locations within the different installments made the probes unpredictable for the viewer. To guarantee that the tone occurred while participants were still reading, each probe sounded out no less than 5 s and no more than 11 s after each participant had clicked "Continue" to begin reading a specific installment. Reaction time was recorded if the participant pressed the key within 2 s of the tone.

Cued Recall

Memory data were collected starting with cued recall via open-ended questions. For each story, there were five open-ended questions, including one asking about the gist of the story to clarify whether participants grasped the substance of each story's content. Answers were coded as either correct (1) or incorrect (0), and a score for each participant for each story was calculated by dividing the number of correct answers by 5.

Recognition

Recognition data were collected through 5-item, four-choice questionnaires for each story. The questions asked

participants to identify specific facts and relationships between concepts that were judged to be at the core of each story. Answers were coded as either correct (1) or incorrect (0), and a score for each participant for each story was calculated by dividing the number of correct answers by 5.

Comprehension

Comprehension was measured using the sentence verification technique (SVT), a measure common in educational psychology. A 12-item test was constructed for each story. Following the Royer et al. (1979) setup for SVT, participants were asked to rate as either “new” or “old” four types of sentences: (1) a verbatim repetition of a sentence that appeared in the original; (2) paraphrase, a sentence in which as many as possible words are changed without changing the meaning; (3) meaning change, a sentence in which at least one word is replaced so that a new meaning is created; (4) distracter, a sentence consistent with the general theme but unrelated to any original sentence.

Procedure

Each participant entered the laboratory, provided informed consent, and sat down at a computer terminal with a 15-inch monitor. First, participants completed a brief pretest measuring their interest and prior knowledge on the topic of each story they were about to read. Participants were instructed to read a short news story and listen for audio tones from the computer. They were told to read each paragraph completely before clicking on “Continue” to move on to the next one and instructed to regard reading as their main task, since they would later answer questions about the text.

The participants were asked to click “Enter” as quickly as possible after they heard an audio tone. A practice trial was conducted, in which each participant read a story similar in length to the experimental stimuli. The practice trial contained three randomly embedded audio tones, one in each third of the message and occurring no earlier than 5 s after a participant had pressed a button to start reading or move on to a new paragraph. Data collection began when participants indicated that they understood the procedure and had no further questions. Stimulus presentation began with instructions appearing on the monitor, followed by the first story. Participants read the story, followed by a 12-item questionnaire on reading enjoyment (not a dependent variable in this study) and the SVT. This process was repeated until all four stories were completed.

After completing all four stories, participants completed a distracter task (an unrelated 60-item questionnaire) to clear short-term memory. Next, participants took a cued recall test in which questions for each story appeared in the same block, but their order was randomized within it. The blocks of questions were also randomized. This was followed by a recognition test consisting of five questions for

each of the four stories, randomized in the same fashion as the cued recall questions. Upon completion of the recognition test, participants were thanked, debriefed, compensated (if foreseen), and dismissed.

Results

Data Cleaning and Reduction

The original sample contained 112 people (46 men and 66 women). In the secondary task reaction time (STRT) dataset, three subjects were removed due to a malfunction of the experimental software that prevented the recording of reaction time in response to audio tones. Four more subjects were removed for persistent timeouts (reaction times exceeding 2 s). The remaining missing data (timeouts) in 21 cells (1.6% of all 1260 cells) were replaced with the mean for the respective column and row. This was considered an appropriate procedure because fewer than 5% of data points were missing randomly, and because the group mean is a more sensible replacement than the overall mean (Tabachnik & Fidell, 2006). For outliers, minimum and maximum allowable values were established as two times the interquartile range beyond the 25th and 75th quartiles. Values beyond these were flagged as outliers and replaced with the allowable values. This process was modeled on Lang’s (2006) approach to STRT outliers, but used replacement values closer to the outlier values while still reducing outliers’ effect. Separate minimum and maximum allowable values were established for male and female subjects. The process identified 17 outliers (1.3%). Additional analysis showed that five of those outliers and several borderline outliers were concentrated within the reaction times of two subjects, who were then removed from the dataset. The remaining 12 outliers (1%) were replaced with the maximum/minimum allowable value. The final STRT dataset contained 103 participants, 40 men and 63 women.

In the SVT dataset, the data for one male subject, who reported having misunderstood the directions for this task, were removed. To test the strength of correct associations versus guessing of correct answers via signal detection analysis, the nonparametric sensitivity measure A' and the nonparametric criterion bias measure B'' were calculated using rates of hits (answering true when an item is indeed true) and false alarms (answering true when an item is false) (Shapiro, 1994). It is to be expected that the number of hits would exceed false alarms, but some participants cannot discriminate well between stimuli and perform below chance, which required the application of alternative formulas (with reversed plus/minus signs in some places) for individual below-chance-performance cases (Aarons & Watts, 1987). If an analysis yielded a significant interaction, Tukey HSD posthoc tests were computed to determine which means in the pairwise comparisons were significantly different from one another.

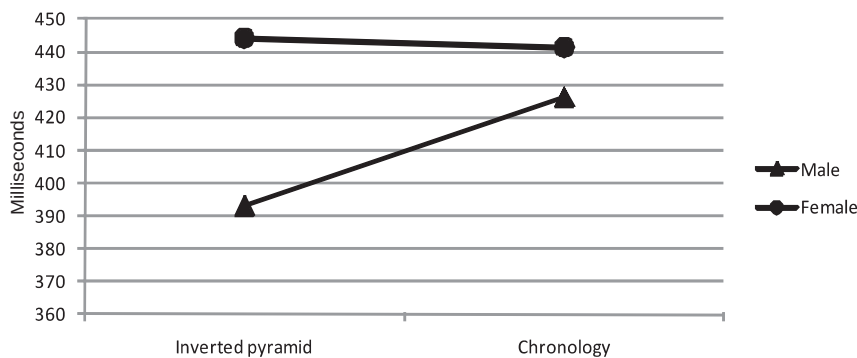


Figure 1. Structure × Sex interactions for secondary task reaction times.

Hypothesis Tests

H1 predicted that for all stories, women on average would show slower secondary task reaction times (STRTs) than men. H2 predicted that there would be an interaction between sex and story structure, such that the mean STRTs for women during reading of chronological stories would be greater (slower) than the mean STRT for women during reading of inverted pyramid stories and the mean STRTs for all men. Both hypotheses were tested by submitting the data to a 2 (Structure) × 2 (Sex) mixed ANOVA with repeated measure on the first factor. There was a significant main effect, $F(1, 101) = 2.82$, one-tailed $p = .05$, with men having faster STRTs than women (Table 1). The structure by sex interaction was also significant, $F(1, 101) = 8.74$, $p < .01$, $\eta^2_{part} = .08$, but H2 was only partially supported. As predicted, women's STRT means for both structures were significantly greater (slower) than men's STRT mean for inverted pyramid stories (Table 2). Women's STRT means for the two structures did not significantly differ from one another, and they were not different from the men's mean for chronological stories; however, both female means were significantly different from the male mean for inverted pyramid stories, according

Table 1. Sex differences in secondary task reaction times (STRTs) during reading

Sex	Means	SD	Power
Male	409.35	101.17	.38
Female	442.51	95.54	.38

to Tukey HSD posthoc tests (Figure 1). According to Baron and Kenny (1986), the significant interaction between two dichotomous variables (structure and sex) means that sex moderates the relationship between story structure and available cognitive resources (of which STRT is the operational measure).

RQ1 asked whether there would be an interaction between sex and structure in cognitive capacity usage (CCU), which was calculated by multiplying each subject's STRT (in milliseconds) by his or her reading time (in seconds) for each passage (Britton et al., 1978). While there was no main effect for sex, $F(1, 101) = .21$, ns , there was a significant interaction for cognitive capacity usage, $F(1, 101) = 6.31$, $p = .01$, $\eta^2_{part} = .06$, such that the male mean for inverted pyramid stories was significantly lower than the male mean for chronological stories and the women's means for both kinds of stories (Table 3).

H3 predicted that there would be an interaction between sex and story structure, such that women's mean recognition for chronological stories would be greater than women's mean recognition for inverted pyramid stories and all recognition means for men. It was tested by submitting the data to a 2 (Structure) × 2 (Sex) mixed ANOVA with repeated measure on the first factor. There was no significant interaction, $F(1, 108) = .42$, ns . H3 was not supported.

H4 predicted that there would be an interaction between sex and story structure, such that women's mean cued recall for chronological stories would be greater than women's mean cued recall for inverted pyramid stories and all cued recall means for men. It was tested by submitting the data to a 2 (Structure) by 2 (Sex) mixed ANOVA with repeated

Table 2. Effect of story structure and sex on secondary task reaction times (STRT)

Structure	Male means (ms.)	SD (male means)	Female means (ms.)	SD (female means)	Power
Inverted pyramid	392.72	99.96	443.89	99.96	.83
Chronology	425.99	104.59	441.13	104.59	.83

Table 3. Effect of story structure and sex on total cognitive capacity usage (CCU)

Structure	Male means	SD (male means)	Female means	SD (female means)	Power
Inverted pyramid	13,763	5,108	15,136	5,108	.70
Chronology	15,464	6,270	15,108	6,270	.70

measure on the first factor. There was no significant interaction, $F(1, 108) = 0.11$, *ns*. H4 was not supported.

H5 predicted an interaction between sex and structure, such that women's sentence verification technique (SVT) score for chronological stories would be greater than women's SVT score for inverted pyramid stories and all SVT means for men. It was tested with a 2 (Structure) by 2 (Sex) mixed ANOVA with repeated measure on the first factor. There was no significant interaction, $F(1, 107) = 1.51$, *ns*. H5 was not supported. There were also no significant interactions for the sensitivity measure A', $F(1, 107) = .77$, *ns*, and the criterion bias measure B'', $F(1, 107) = .01$, *ns*.

Discussion

This study found significant interactions between sex and story structure for STRTs, as hypothesized, and a significant interaction for cognitive capacity usage. However, there were no significant interactions in the recognition, cued recall, and text comprehension datasets. There was also a significant difference between men and women in reading news stories (regardless of structure), women having slower STRTs than men. These results are discussed in light of their theoretical and practical implications.

Theoretical and Practical Implications

Women's slower reading STRTs have to be considered in light of women's linguistic advantages, which include better verbal memory (Kramer et al., 2006), text comprehension (Hedges & Nowell, 1995), better ability to recover linguistic performance after brain damage (Shaywitz & Shaywitz, 1995), and somewhat earlier language acquisition (Schachter, Shore, Hodapp, Chalfin, & Bundy, 1978). Women's STRTs might be slower because they are more engaged and busier than men in constructing meaning from text. From the standpoint of the comprehensibility hypothesis (Britton et al., 1983), this means they have fewer available resources to deal with the secondary task. In that explanation, women should spend a lot of cognitive resources on reading.

On the other hand, from the standpoint of what Lang outlines as the standard STRT paradigm (Lang et al., 2006), women's STRTs might be slower because reading is relatively effortless to them to the point that they allocate very few resources to this process and thus have very few left to react to the secondary task. In other words, the resource allocation for reading tasks can be assumed to be lower for women (super-task level). Even if they actually need less resources for the reading (subtask level), the remaining resources could be limited for other simultaneous cognitive activities. Lang et al. illustrate the concept of allocated resources figuratively as the cognitive price one is willing to pay for processing a media message. This price may be different, likely higher, from the cost it actually takes to process the message, or re-

sources required. Thus, the rationale behind the argument that women may allocate fewer cognitive resources for effortless reading is that easier tasks likely elicit more accurate judgment of cognitive processing cost and a relatively small buffer between allocated and required resources.

It can also be speculated that women's slower STRTs during reading are simply an example of a female disadvantage in reaction time, observed by Pesta, Bertsch, Poznanski, and Bommer (2008). However, at least one study (Schmitt, Lelerc, & Dube-Rioux, 1988) found just the opposite: shorter response latencies among female participants.

The finding that story structure makes a greater difference to men than to women (men had significantly slower STRTs for chronological stories than for inverted pyramid stories, while women's means were nearly identical) poses a challenge to the view that a masculine style of communication is direct and parsimonious (Wood, 2007).

If slower STRTs are interpreted to indicate ease of processing and creation of meaning, then men had an easier time and/or created more meaning when processing chronologies. In the realm of speculation, this may be due to an evolved male ability to process action as it develops in time, which may have been advantageous for hunting and defending the family. Perhaps one example of that is that men enjoy action films more than do women (Peterson & Pang, 2006). From the standpoint of the LC4MP, slower STRTs could also mean that men allocate fewer resources to (the presumably easier) chronological stories and hence have fewer resources left for the secondary task. Once again, the logic here is that if the primary resource allocation for some reading tasks is relatively low (and even if the consumption of resources for these tasks is also low), the resources remaining for other simultaneous cognitive activities could be limited.

On the other hand, if faster STRTs are simply interpreted to indicate ease of processing, then men did better at processing inverted pyramid stories, as predicted (a simple limited resources account). The finding that men reading inverted pyramid stories had the lowest cognitive capacity usage could be viewed as supporting such an interpretation.

The frequent use of the inverted pyramid structure in print and online news does not seem to present a problem for female readers. In fact, under Britton et al.'s (1983) comprehensibility hypothesis, it hardly made any difference to women what story structure they were reading. This is consistent with a previous finding that women are less discerning than men when it comes to story structure (American Society of Newspaper Editors, 1993).

There were no significant differences between men and women in terms of recognition, cued recall, and the comprehension measure. It is also possible that the lack of temporal demands during reading (unlike the case of video/audio messages) minimized the hypothesized differences in memory outcomes. The lack of differences may be due also to a ceiling effect (especially in the case of recognition, where means approached 80% accuracy), which suggests the need for more difficult questions about finer details rather than the main points of each story.

Limitations and Directions for Future Research

Several significant interactions between structure and story (when coded as topic) emerged in the results, suggesting the choice of two different topics (health and science/technology, meant to balance men's and women's presumed interests) may have been a limitation. In future research, it would be reasonable to limit topic variance by presenting messages from similar domains. Although order was assigned randomly, we did not ensure an equal number of males and females were in each condition (order). Condition interactions that were observed could have potentially been eliminated if an equal number of men and women were in each condition. This could also have further boosted the observed sex differences.

In future exploration, we plan to present participants with only three or four words at once, allowing them no control over the pace of reading (to make the case similar to processing broadcast stories), and asking them to respond to visual probes embedded in the message. Another option is to look at the interaction between sex and "chunking" (presenting stories in multiple installments, as is usually the case in online news). Given women's preference for context, it is likely they will display more ease in reading "whole" rather than "chunked" stories.

Another possible route is to compare the effect of stories about people and about inanimate objects. Some literature suggests women would employ more cognitive resources in reading about people because they tend to be more socially interdependent than men (Clark, Steer, Beck, & Ross, 1995). Given the constantly emerging new findings from psychology and cognitive neuroscience, including about sex differences in the brain, it is important that sex no longer remains a forgotten variable in mass communication research.

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