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The Effect Of Story Structure On Memory For Technical Instructions

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THE EFFECT OF STORY STRUCTURE ON

MEMORY FOR TECHNICAL INSTRUCTIONS

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I HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER MY SUPERVISION BY PAMELA DOWLING ENTITED The Effect of Story Structure on Memory for Technical Instructions BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF Doctor of Philosophy.

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Abstract

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The Effect of Story Structure on Memory for Technical Instructions

Stories represent an important key to how people remember information. Psychology has characterized stories in terms of grammars, which are lists of components typically found in stories (e.g., setting, protagonist, causal sequence etc.). This has a tendency to limit the definition of a story to grammars and negate the importance of ideas such as content. The present research hopes to expand the definition of a story by introducing another set of literature, namely speech act theory. According to speech act theory, conversations include more information than regular text regarding expectations among the conversational participants and common patterns of conversational exchange. By extension, the presence of conversations in stories may affect how stories are comprehended. Participants read and answered questions pertaining to three stories about car repair, all of which contained the same basic story grammar elements. Two versions of the stories were created that enhanced the story grammar components. A speech act version contained present tense conversations. An additional version included some conversations along with references to information found in a technical manual. After adjusting for reading level, the accuracy of participant responses supported the claim that the speech act version of the story was easier to remember than either the story grammar or the technical versions. Total response times also distinguished the speech act version from the other versions. Separate analyses for response times to true and false questions suggested no difference between true and false response times for the speech act version.

The analysis of the true and false questions for story grammar and technical story types showed the expected effect for one version of the experimental questions. Speech act stories therefore elicited a different pattern of responses to the same questions. Cognitive theory must accommodate this result, either as a function of reading strategies or processing pathways.

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The Effect of Story Structure on Memory for Technical Instructions

From birth to old age, stories fill our lives. Nursery rhymes, Steven King novels, and television programs convey information in story form. Other arenas of life rely just as heavily on stories. Ask someone to describe their past and most likely they will embark on a story. Storytelling is rampant in conversations, written language, and oral testimony. Children as young as 2 years of age recognize and tell coherent stories (Ames, 1966; Brown & Hurtig, 1983). The ubiquitous nature of stories is undeniable. Stories are used to remember events, communicate ideas, and interact socially (Schank & Abelson, 1995a). Cultures throughout the world have relied on stories to share histories and wisdom (Graesser & Ottati, 1995). People define themselves by their story (Polkinghorne, 1996b; Rubin, 1995; Sacks, 1985). We are predisposed to organize input, whether that input comes from personal experiences or text we have read, in narrative form (Bruner, 1990; Mancuso, 1986). Perhaps we are so predisposed to hear and process information in terms of stories that information should come in story form from the beginning. Unfortunately, in many settings such as classroom lectures, technical manuals, and training workshops, stories are avoided. Some interviewers, annoyed by the propensity for storytelling, actively detour people away from telling stories (Phillips, 1995; Polkinghorne, 1988). If people are so quick to tell stories, perhaps this tendency is important in how people interact with their surroundings.

Stories may teach information that otherwise might be difficult to communicate. Of the many arenas where learning occurs, communicating technical instruction is one often fraught with difficulties (e.g., Shalin, Prabhu, & Helander, 1996). Self-help books and how-to books attempt to overcome difficulties in understanding by communicating information in story form. Books designed to teach the reader not only to understand a concept, but also to be able to act on that knowledge, may include stories. The authors of these books do not expect readers to follow the principles written in the books without making those principles concrete by putting them in story form. As a case in point, a Home Depot home improvement book does more than describe the steps involved in replacing a toilet or fixing a light fixture. With inserts entitled “Homer’s Hindsight,” the book describes what others have done correctly or not so correctly. The hints appear to make the instructions more human, more easily applicable. Perhaps, when you read about someone who tried to use a snake tool on their toilet, was too rough with the instrument, and ended up with a heap of broken china, you are more likely to remember their mistake and not repeat it. These writers believe that the effect of the hints is not the same as the effect of including the information about being careful with the snake in the bland list of instructions. Folk wisdom promotes the inclusion of personal stories to improve retention of information from self-help books. Research on stories is important because it can help us understand the folk appeal of stories for instructional purposes and systematically examine the potential of stories for communicating technical information.

The following portions of the introduction first addresses the use of stories for applied problems including knowledge management in organizations, adult training, elementary education, and eyewitness testimony. The next major section presents the research on stories from a cognitive perspective, focusing on the definition of stories and their effects on memory. The introduction concludes with an overview of and rationale for the experiment conducted here, which was designed to identify the role of speech acts as a source of benefit of stories in the communication of technical information.

Stories in Organizations

The knowledge management literature has examined the use of stories in organizations. Researchers have suggested that stories serve as observable representations of an organization's culture (e.g., Coupland, Blyton, & Bacon, 2005; Dunford & Jones, 2000; Oseroff-Varnell, 1998; Patriotta, 2003). When studying storytelling in an organization, researchers have looked for metaphors and themes in conversations. When a theme can be derived from stories told in an organization, that theme can show how employees perceive their work place.

Stories reflect how speakers organize individual facts about the world and elucidate knowledge that is typically hidden (Hill, 2005). Boje (1991) defined storytelling as a "pattern-finding, pattern-elaboration, or pattern-fitting episode to make sense of wider organization processes and relationships" (p. 113). Storytelling, in this view, is the vehicle people use to integrate the disparate circumstances that surround them into a coherent whole. Those who study stories in organizations can gain descriptive information about business climates that allow predictions about future corporate behavior.

The communication patterns used in organizational settings are a reflection of the views people hold in that organization (Coupland, Blyton, & Bacon, 2005). New members pick up these views as they interact with old members through the process of informal training. Analyses of stories used within a group can identity perspectives and feelings about people and situations even when those feelings are not in conscious awareness. Management can invoke stories to train employees how to interpret situations (Dunford & Jones, 2000). This can be done through couching material taught in training seminars into stories, or stories can be delivered through less obvious methods. Employers can tell stories about past events and emphasize desirable behaviors and/or vilify inappropriate behaviors in context. As these stories are passed around the work environment, the themes can infiltrate how people perceive the desirable or vilified behaviors.

Stories in Adult Training

Stories can be used to train and track the training of adults. When stories are used in training, they help people remember and respond to their training (Cianciolo, Cianciolo, Prevou, & Morris, 2007, Lamsa & Sintonen 2006). There have been some attempts to apply the benefits of storytelling in adult education. Stories were found to be more persuasive than informational messages when encouraging farmers to install rollover protection devices on their tractors (Morgan, Cole, Struttmann, & Piercy, 2002). Stories also were found to be effective in training miners (Cullen & Fein, 2005). Training material that featured real miners telling stories of hazards as they saw them led the recipients of the training to be much more receptive to the information. Another study applied stories to disseminate expert knowledge to novices (Hernandez-Serrano, Stefanou, Hood, & Zoumas, 2002). These researchers took stories from experts and mapped them into a database. Novices learning a trade would then navigate through stories that would help them while they problem solved. Those who read the stories were better at solving problems than those who read information arranged into fact sheets dissociated from context.

Stories in Education

The value of stories in primary and secondary education and instruction has not been overlooked (e.g., Bransford & Franks, 1972; Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Freedle & Hale, 1979). Teachers rely on the use of stories in their classrooms to convey concepts. They understand that stories affect how we remember and take in information. Stories are used to connect actions and events to make them understandable (Bruner, 1990; Polkinghorne, 1988; Schank & Ableson, 1995a). Effective teachers are those that know how to couch the information they are sharing in meaningful ways (Schank & Abelson, 1995a). The story is one such meaningful package.

Anchored instruction and case-based reasoning. The teaching techniques of anchored instruction and case-based reasoning have incorporated the use of stories (e.g., Bransford et al., 1990; Bransford et al., 1993; Kolodner, 2002; Kolodner et al., 2003; Kolodner et al., 2004; Williams, 1992). Anchored instruction aims to keep instructional situations 'anchored' in more realistic contexts than the typical classroom allows (Bransford et al., 1990; 1993). The goal is to provide students with in-context situations, which will be intrinsically interesting. In case-based reasoning, students are presented with a scenario and asked to apply strategies from that scenario to future problems (Kolodner et al., 2004). The above noted citations have supported the claim that both anchored instruction and case-based reasoning techniques yield improved learning and understanding in classroom settings. Both use stories as the means to present information to students.

Bransford and colleagues (Bransford et al., 1990; Bransford et al., 1993) have developed an instructional technique based on interaction learning that has stories at its core. This approach, known as the Jasper Series, has combined project-based scenarios with information from experts in different areas. Students participating in this series are encouraged to find solutions to the problems or to research areas of interest in a presented scenario. The approach hopes to keep the acquisition of new information anchored to a context so that learners do not learn information for information's sake but as a means to something else. Those advocating the Jasper series have proposed that students do not learn individual inputs, but instead are predisposed to learn in larger semantic contexts. The Jasper effort has focused on developing materials and procedures to aid teaching. The components that are involved in this venture are numerous, and teasing out the impact of just the use of stories, let alone types of stories, would be difficult if not impossible. Those responsible for creating the educational material may not have been looking to the benefits of stories per se. However, their instinctive use of stories is another example of people relying on stories to communicate ideas.

Stories also have impact when students deliver them. Students who tell stories about their experiences are more likely to remember that experience (Cortazzi, Jin, Wall, & Cavendish, 2001). The activity of telling a story about what students have learned makes them share their learning experiences and increases the confidence students had in their acquired knowledge. The authors have suggested that storytelling can be used as a means to help students cement information they have learned.

Stories as vicarious experience. Learning by doing is a tried and true method of teaching (Gould, Jeter, & Cook, 1972; Lesgold, 2001; Piaget, 1952, 1973; Whitehead

1957). Unfortunately, it is not always possible for students to "do" the learning. This is where stories can be beneficial. Perhaps the next best thing to learning by experience is learning by someone else's experience (Ferguson, Bareiss, & Osgood, 1992; Williams, 1992). Stories may be best used when told while a person is attempting a task (Ferguson, Bareiss, & Osgood, 1992). When the action is not possible, stories are the closest teaching technique to actually doing the thing being taught. Though the action is not taking place, people can imagine the action taking place. Perhaps stories are so useful in learning and memory because though 'experience is the best teacher,' stories constitute a kind of vicarious experience.

Stories, Eyewitness Testimony, and Embellishments

Stories have the benefit of being natural communicators and being easy to remember (Bruner, 1990; Neuhauser, 1993; Robinson & Hawpe, 1986; Schank & Abelson, 1995a). However, people who tell stories can introduce embellishments. Loftus' research (e.g., Loftus, 2004, Loftus & Davis, 2006; Wade et al., 2007) has investigated the malleability of knowledge in memory. When examining the arena of eyewitness testimony, Loftus and her colleagues have found that people construct stories to make sense of events. The stories in these cases may or may not be accurate, and the degree of confidence in the story does not equal the veracity of the story (e.g., Loftus, 2004; Loftus & Davis, 2006; Mazzoni, Vannucci, & Loftus, 1999). People even have a hard time remembering stories they tell about themselves. When presented with this type of evidence, one might wonder if stories are just a means of filling in missing information, or if we are actually remembering. Do stories simply increase the confidence learners have in their understanding while increasing the possibility for error (Cortazzi et al., 2001)?

Evidence from Loftus' research (e.g., Loftus, 2004; Loftus & Davis, 2006) among others (e.g., Bartlett, 1932) has shown clearly that errors can be introduced into recalled stories. Mistakes arise when people pull information from their memories. In fact, all memory is susceptible to error whether it is in story form or not. Though inaccurate knowledge is certainly undesirable, it is in some respects unavoidable. The use of stories to tell and retain information will allow for mistakes. Perhaps stories allow more mistakes than other types of memory because of the reliance on schemas to support inference. This is a limitation, but the benefits that come from stories, such as their superior ability to communicate information, may outweigh the difficulties they introduce.

Though it is no doubt important to have accurate information, some of the embellishments stories are susceptible to are not problematic. This can be demonstrated using a classic paradigm where subjects are presented with sentences and then later shown sentences and asked if they were the same or different. Typically there are many false positives where people recognize sentences they never actually saw. One reason for this is that they remembered the semantic content rather than the specific word configuration (Bransford & Franks, 1972; Trabasso, 1973). The basic content of the story, or in this case sentence, is remembered even if the precise words are not.

In most cases of learning (especially outside the classroom), verbatim memory of the information is not required, understanding is enough and many times preferred. Even classroom teachers want students to be able to formulate information in their own words, not parrot back what they have heard. Stories may be prone to both elaboration and loss of some details, but this is not necessarily a cause for concern. Rather this suggests people are not just repeating what they are hearing. If a student can tell a story about what they have learned, they may have a better understanding of the gist of the information rather than a superficial memory of the same.

The Role of Stories in Memory

Researchers examining storytelling have pointed to stories as the mechanism we use to understand the world (Bruner, 1990; Fuller, 1982; Schank & Abelson, 1995a). These researchers have claimed that stories are common in communication because there is something about stories that seems to be easily understood and remembered. This predisposition[1] is not limited to a specific culture, education, or age group (Mandler, 1984; Mandler, Scribner, Cole, Deforest 1980; Fuller, 1982). Stories told in different cultures and different language groups exhibit similar properties.

Claims about the importance of stories in memory range from Schank and Abelson's (1995a) intentionally inflammatory remark that all knowledge is based on stories to softer claims from Robinson and Hawpe (1986) that communicating experiences through stories is a natural process. Most theorists who have commented on stories support the importance of hearing, telling, and storing information in story form (e.g., Baumeister & Newman, 1995; Brewer, 1995; Bruner, 1986; Schank & Abelson, 1995a, 1995b). Certainly, some types of information can be separated from story content. Numbers, propositions, and images represent types of information that may not

[1] This predisposition to understand stories may be an innate quality such as the deep structures Chomsky discusses (Chomsky, 1957; Baumeister & Newman, 1995), or it may be a skill learned from society. That discussion is outside the realm of this study. Instead, the importance of stories in understanding information will be the focus.

fit neatly into a story (Baumeister & Newman, 1995). A question that could be asked is whether distilling (for instance propositional) knowledge from the content of a story is how people remember. Do we remember the steps and principles necessary to fly a kite? Or do we remember taking a kite to the park and watching our dad hold the kite while we ran down a hill?

What is a Story?

There are many opinions from different disciplines about what makes a story. Though everyone seems to know instinctively what a story is, defining exactly what composes a story is a difficult task (Leitch, 1986). Literary critics and linguists have examined aspects such as the emotion a story evokes or what point of view the author takes (e.g., Booth, 1961; Hallman, 2008). Modern and postmodern literary critics have enjoyed stretching the concept of a story to its limits (Ricoeur, 1984). However, finding the outermost edges of what might be passable as a story does not tell us how people think about typical stories. The following sections will identify how psychologists traditionally have defined stories. Evidence will be presented in support of the traditional view from both foundational studies in story research and current undertakings. The sections will continue with a reaction to that view.

Story grammars. When psychologists defined stories, they attempted to find core components that can be found in most stories. These components, identified in story grammars, typically include a setting or beginning event, a predicament, a protagonist who reacts, and an ending. They are often tied together temporally and causally in what might be called a plot. Though not always agreed upon, the different definitions do tend to overlap. These components have been grouped together to form story grammars.

Story grammars are sets of rules describing how stories are organized. They have been developed by examining what has already been written and then identifying categories in the text. Researchers have hoped that categorizing text into grammars approximates the categorization scheme people use to organize stories in their minds (e.g., Mandler, 1984; Mandler & Goodman, 1982; Thorndyke, 1977).

Story grammars first identify the components that are separable and essential in a story. Once identified, those essential parts then become the researchers' definition of a story. When attempting to identify these components, the work by Stein and Policastro (1984) has formed an oft-cited definition of a story (e.g., Mancuso, 1986; Robinson & Hawpe, 1986; Weick, 1995). After comparing many types of stories based on several theories, the only aspects Stein and Policastro (1984) could clearly claim necessary in a story was an animate protagonist and some type of causal sequence of events. Though these researchers may have claimed that the basic story need only include a protagonist and causality, there are many other components that have regularly been found in stories such as a setting, plot, and episodes (e.g., Hill, 2005; Leitch, 1986; Mancuso, 1986; Mandler, 1984; Mandler & Goodman, 1982; Phillips, 1995; Robinson & Hawpe, 1986; Stein & Policastro, 1984; Thorndyke, 1977 and many others).

Story grammarians have also listed components such as abstracts, codas, internal intentions, emotional responses, and physical change (e.g., Graesser, Singer, & Trabasso, 1994; Hill, 2005; Hogan 2006; Mandler, 1984; Mandler & Goodman, 1982; Reiser, Black, & Lehnert 1985). Many of the components mentioned by those who research stories, such as the protagonist, are self-explanatory. Some of the story components require more explanation. As such, plot, causality, and temporality will be discussed below.

Plot. Plot transforms a list of incidents into a narrative; it connects and creates meaning between separate story components (Phillips, 1995; Polkinghorne, 1996a, 1988, 2004; Ricoeur, 1984). Plot has been defined as the "syntax of narrative discourse" (Polkinghorne, 1988, p. 160). Plots create or entwine events into a story using temporal markings that link one event to another and give meaning to the inclusion or exclusion of events (Polkinghorne, 2004). Plots connect events into a unified story. Plots take disjointed incidents and make them into an integrated whole.

Though researchers have attested to the importance of plots to stories, there is no clear consensus on a typology of plots (e.g., Leitch, 1986; Lehnert, 1981; Phillips, 1995; Polkinghorne, 1988; Robinson & Hawpe, 1986). Whereas plot types resist identification, one might identify characteristics of plot. In particular, the concepts of causality and temporality are mechanisms used in plots to accomplish their linking function.

Causality and temporality. Many researchers have supported the importance of causality in stories (e.g., Hill, 2005; Fuller, 1982; Leitch, 1986; Mandler, 1984; Michotte, 1963; Polkinghorne, 1988; 2004; Stein & Policastro, 1984) as well as temporality (e.g., Bruner, 1990; Hill, 2005; Leitch, 1986; Polkinghorne, 2004; Mandler, 1984; Stein & Policastro, 1984) for forming relationships between events. According to some (e.g., Leitch, 1986; Polkinghorne, 1988), stories must have both causality and temporal order. Many others point to both causality and temporality being expected in stories (e.g., Hill, 2005; Leitch, 1986; McAdams, 2006; Mandler, 1984; Robinson & Hawpe, 1986). Authors like James Joyce have made temporality an unnecessary component in stories, but as McAdams (2006) comments, the most important element of a story is that it is comprehendible by its listeners or readers. Most storytellers do not have Joyce's ability to make an a-temporal story understandable, which is probably why temporality is a common component. The emphasis on causality and temporality as integral to a story would seem to suggest that temporally and causally organized technical instruction should show the same advantages as stories for comprehension and memory.

Research Results on Stories

Those researching the importance of story grammar components have claimed that people do break stories into general categories or components and respond differentially to those categories (e.g., Bower, Black, & Turner, 1979; Mandler & Goodman, 1982; Mandler & Murphy, 1983; Whaley, 1981). Stories having more components have been rated as more complete and as better stories (e.g., Robinson and Hawpe, 1986; Stein & Policastro, 1984). Research has told us that when story components were given out of order they were harder to remember (Mandler & Goodman, 1982). When stories lack information necessary to comprehend the different components, people have had a harder time remembering (Bransford & Johnson, 1972; Mandler & Johnson, 1977; Morris, Stein, & Bransford, 1979). As noted previously, other research has found that if story components are missing, people fill in the gaps (Bartlett, 1932; Mandler, 1984; Mandler & Johnson, 1977). Stories that have more story components also were better remembered than stories with fewer components (Stein & Glenn, 1979; Thorndyke, 1977). At first glance, this last line of evidence may appear counterintuitive. It would seem logical that more information is harder to remember. This line of research appears to echo Gestalt principles (Hergenhahn, 1997; Horthersall, 2004; Lowry, 1982) rather than Ebbinghaus' memory for lists (Fancher, 1996). The whole story fits together in memory better than bits of the whole.

There is much evidence consistent with the role of story grammars in memory (e.g., Bower, Black, & Turner, 1979; Mandler & Goodman, 1982; Mandler & Murphy, 1983; Robinson and Hawpe, 1986; Stein & Policastro, 1984; Whaley, 1981). Some researchers might say that we do not ever remember all the bits of a story but rely on our mental representation of story grammars to fill in the information during recall (Robinson & Hawpe, 1986). The evidence has suggested that people have memory structures that relate to story components and that the presence or absence of these components affects memorability of a story. Most theorists from the story grammar perspective have relied on the common structures that can be found in stories to explain why stories are memorable. From this perspective, the structure of a story is a standardized base onto which people can easily map new information. Most of the emphasis is placed on the structure of a story and little is placed on the content of the story.

Though many story grammar researchers have developed grammars in increasing levels of detail, there is debate as to whether story grammars can be used to identify any consistent story structure (Black & Seifert, 1985; Black & Wilensky, 1979; Johnson-Laird, 1983). Those who promote grammars are continually updating them to include as many possible variations of a story as possible. The result is increased complexity in tree diagrams of stories. Even with the numerous attempts to map out the space, there always seems to be some story that does not fit. Alternatively, the grammars have to allow for exceptions to their grammars and the deletion and addition of components. With these necessary variations, some have lost confidence in the story grammar approach. Another perspective has approached stories as a whole unit (e.g., Polkinghorne, 1988, 1996; Stein, 1982). In this view, the structure is no more important than what is actually conveyed.

Stories and Content

Some take a different approach to stories, which seem to be inconsistent with story grammars (Bruner, 1990; Polkinghorne 1988; Schank & Abelson 1995a). Proponents of what might be called a holistic approach think the memorability of stories can be found in the content or the substance of the story. The importance of content in being able to remember information has been well established (Bartlett, 1932; Bransford & Johnson, 1972; Bruner, 1990; Trabasso & van den Broek, 1985). The distinction between grammars and content mimics the discussion between syntax and semantics addressed by Chomsky (1957; Bruner, 1990). Stories are not just components arranged in story syntax. The content in the story makes the pieces cohere together and makes it memorable. A story may have all the grammar components and still not make sense if the content of the story is not taken into account.

It may be possible to break down stories into their individual parts, but some emphasize the importance of telling and receiving stories as whole units. Perhaps stories are remembered better not because they are a collection of ideas that fit into individual slots in a story grammar but because the compilation of those ideas forms something more (Polkinghorne, 1988). Understanding a story comes from understanding the interrelation between the parts, not just the parts themselves, as any Gestaltist would argue. A sentence is more than individual words, and in a similar manner, stories may be more than components in a grammar (Johnson-Laird, 1983; Polkinghorne, 1988; Ricoeur, 1976).

Story researchers who have relied on grammars may be enticed by the ability to break apart different story components into story grammars. They seem to take an approach to stories similar to the categorization theorist (Johnson-Laird, 1983; Stein & Policastro, 1984). Objects are classified by such means as category and genus. Story components have been similarly classified (Mandler, 1984; Thorndyke, 1977). Some critics have commented that stories may not be composed of individual objects to be ordered separately (Johnson-Laird, 1983; Polkinghorne, 1988; Ricoeur, 1976). Even the proponents of story grammars still caution against treating story components as independent entities (Black & Wilensky, 1979). The meaning of an individual component cannot be divorced from the meaning of other components in that story (Bransford & Franks, 1972). Meaning does not come in bits; it comes in packages.

In the words of Bruner: "People do not deal with the world event by event or with text sentence by sentence (1990, p. 64)." However, taking a story as a whole does not mean that ideas like grammars are not used when interpreting text. Bruner continues to say that people "frame events and sentences in larger structures, whether in a schemata of Bartlett's memory theory [1932], the 'plans' of Schank and Abelson [1977], or the 'frames' proposed by Van Dijk [1980]. These larger structures provide an interpretive context for the components they encompass." The holistic approach mentioned here should be seen as a call to a balance or an alternative perspective. To understand the impact of stories, it is important to look at not only story syntax-(grammar), but the semantic-(content) aspect as well. As Neisser (1988) pointed out, the biggest contribution of research into stories is not in any particular schema map, but in the interest paid to the importance of stories in memory. Grammars may have been able to identify components in stories that people have responded to, but grammars may not have captured everything that makes a story.

Story Content and Analogical Transfer

Several studies of analogical transfer use stories as experimental stimuli (e.g., Gentner, Loewenstein, & Thompson, 2003, 2004; Gick & Holyoak, 1980, 1983, 1987; Holyoak & Koh, 1987), which have directly addressed the ability to overlook content in transfer. These researchers have looked for a way to help people problem-solve by applying information learned in one arena to another, a technique somewhat comparable to case-based reasoning strategies. Studies of analogical transfer have attempted to find a way to help people move beyond the superficial features of a problem and identify underlying similarities between different problems. That is, they tracked whether people were able to eliminate content. Participants were presented with one problem in the first sitting and then presented with a structurally similar, but superficially different, problem at another time (Bassok, 1990; Gentner, Loewenstein, & Thompson, 2003; 2004; Holyoak & Koh, 1987). Researchers have hoped that the first problem would be remembered as a prior familiar situation to be applied to the second problem. The results of these studies indicated that if people could abstract general principles away from the content of the story, they were better able to comprehend and apply that knowledge. However, the abstraction process on a single story was not automatic.

Researchers have sought methods that encourage analogical transfer, but as the data suggests, this is very hard to accomplish. Even those times when participants were able to apply information from one scenario to another, they usually only did so after specific guidance from experimenters. Subjects reading these scenarios often did not see similarities between stories couched in different content. One study conducted by Holyoak and Koh (1987) looked not just at structural similarity (as most studies in analogical transfer do) but also at what they called surface similarity, or what also might be called content or semantic similarity (the topics in the stories were similar rather than just the structure of the problem). In this study, both the structural and surface similarity needed to be similar to the transfer problem for participants to recognize the potential for transfer. Applied to the storytelling literature, this could suggest that the content (what Holyoak and Koh (1987) called surface information) as well as the structure of stories were both important in comprehension.

The diverse proponents of holism do not make any particular claims about problem solving ability per se, but they would likely say that partitioning information away from its content appears counterproductive.[2] The problem solving literature and holistic perspective seem to be at odds regarding the need for abstraction. The problem solving literature has focused on the ability to find solutions to problems by applying information from another source, necessitating abstraction. The other has emphasized the use of the content and structure of the story in retaining and conveying information from memory without abstraction.

Analogical transfer researchers point to the first story as a prior familiar situation that primes the subject in the principle that was important to transfer. Perhaps the prior familiar situations referred to in these experiments were not all that familiar when compared to the familiarity of story structure (Novick, 1988; Reed, 1987). Potentially, one of the benefits of stories is not the content of the stories but the underlying story

[2] An idea echoed by Lave's research (e.g., 1992). She has amply demonstrated that people are effective problem-solvers in content rich situations.

structure. If this is the case, the analogical transfer literature (e.g., Bassok, 1990; Gentner, Loewenstein, & Thompson, 2003; 2004; Holyoak & Koh, 1987) and the story grammar literature (e.g., Bower, Black, & Turner, 1979; Mandler & Goodman, 1982; Mandler & Murphy, 1983; Whaley, 1981) are consistent. Both advocate that structural familiarity aids understanding or transfer. The analogical transfer literature finds the familiarity in the "deep" structure of the previously viewed scenario. The story grammar literature finds the familiarity in the story structure found across stories. However, if the benefit of stories in aiding memory were rooted in the content of the story, then abstracting underlying principles from the content (as advocated by the analogical transfer literature) should be counterproductive. When subjects rely on the content of the scenario to understand the principles, the underlying structure is less important and perhaps factors less into the ability to problem solve.

Speech Acts

Story grammar research has encouraged a singular perspective on stories. Perhaps looking from a different perspective will aid our understanding of stories. Elaborating on the idea that stories are good communicators, speech act theory may lend another perspective to our understanding of stories, specifically when the stories include conversation. Conversation is the original basis of language (Fillmore, 1981). According to speech act theory, conversations communicate large amounts of information apart from the actual words used (e.g., Levinson, 1983; Miller, 1974; Thorne, 1974). People entering into a conversation have expectations about how information will be conveyed because conversations follow rules. Thus acceptance or rejections follow requests whereas denials or affirmations follow assertions. This framework of expectancies or rules guides the reader in interpreting and understanding the content of the conversation (Johnson-Laird, 1983). Perhaps people approach stories with conversations differently than stories without conversations. The following sections outline some rules conversations tend to follow.

Grounding. When two people speak to each other, multiple rules or guidelines exist to assist in the communication of meaning. Grounding is the process of trying to establish or identify what is common among the people in the conversation. Commonalities include the shared backgrounds and experiences of the discussants as well as a mutual understanding about the subject of the conversation (Clark & Brennan, 1991). Discussants update their grounding through exchanges in the conversation. Most exchanges consist of a speaker uttering a statement and the listener showing that they accept and understand the statement (or not). If the listener hints that they have not understood what is being conveyed (grounding was not accomplished), the speaker usually will try again to convey the information.

When listeners do understand (grounding is achieved), they give evidence such as acknowledgements, relevant turns, and continued attention (Clark & Brennan, 1991). Acknowledgements are subtle positive feedbacks such as “uh huh” and “yeah.” Nodding is a common nonverbal acknowledgement. A relevant turn is accomplished when the listener becomes the speaker but continues the line of conversation the previous speaker had begun. Continued attention occurs when the listener continues to pay attention to the conversation. The rules governing conversations allow others to understand what is being communicated. Even those who are not a part of the conversation might assume that if affirmations are given, the material is understandable. If reversals or irrelevant turns are given, those outside of the conversation can gain insight into the understandability of the material being discussed.

The cooperative principle. The cooperative principle tells us that people will say as much as is required by the context of the conversation to satisfy the purpose of the exchange (Grice, 2002; Levinson, 1983). Under the cooperative principle, there are several identified guidelines for conversational behavior identified as maxims or principles (Clark & Wilkes-Gibbs, 1986). The maxim of quality states that speakers believe what they convey is the truth. The maxim of quantity regards the amount of informative content given by the speaker. When the maxim of quantity is followed, responders are informative but succinct. The maxim of relevance suggests that people most often make remarks that relate to the subject at hand. When following the maxim of manner, communicators will avoid obscurity and ambiguity. The principle of least collaborative effort tells us that people do not spend an exorbitant amount of energy making sure the words they utter have no mistakes or include everything they mean. They will instead rely on the ability to correct any perceived misunderstandings in the course of the conversation.

Thus, participants in a dialogue follow the above maxims and expect them to be followed by those around them. Because these maxims can be relied on, communicators and observers can decode the information, though it is not as easy for an observer to understand the conversation as those actually conversing (Schober & Clark, 1989). However, conversations are predictable, and the rules governing discourse can aid how others understand what they hear or read.

Speech act theory offers a different explanation for the story benefit. Stories with conversations may be read differently than stories without conversations. When reading about other people's conversations, one assumes that the confusing portions of the dialogue will be made apparent by the responses of the recipient and that the confusing parts will be explained further. If no mention is made of something being difficult to understand, one assumes whatever was communicated was easy to understand. Our expectations of how conversations are played out influence how we understand what we hear or read and may assist in the reconstruction of missing memory. For example, stated problems must evoke a response in the listener. Thus, one benefit of a story may lie in the general stance readers apply to the content of dialogue.

Summary

The above discussion addressed the prevalence of stories in communication and attempted to define the concept of a story. The prevailing perspectives on how we interpret story information, as presented here, appear in the literatures that champion the story grammar approach. Though the story grammar literature shows one approach to how someone might read a story, there are those who caution that stories should be considered whole units. An additional approach mentioned here discussed the possible influences of speech acts in how text with conversations is understood. Both the holistic and speech act theories suggest an alternative approach to understanding stories. These latter ideas suggest that people come to stories with more than a pre-structured schema for plots and causality.

Current Research

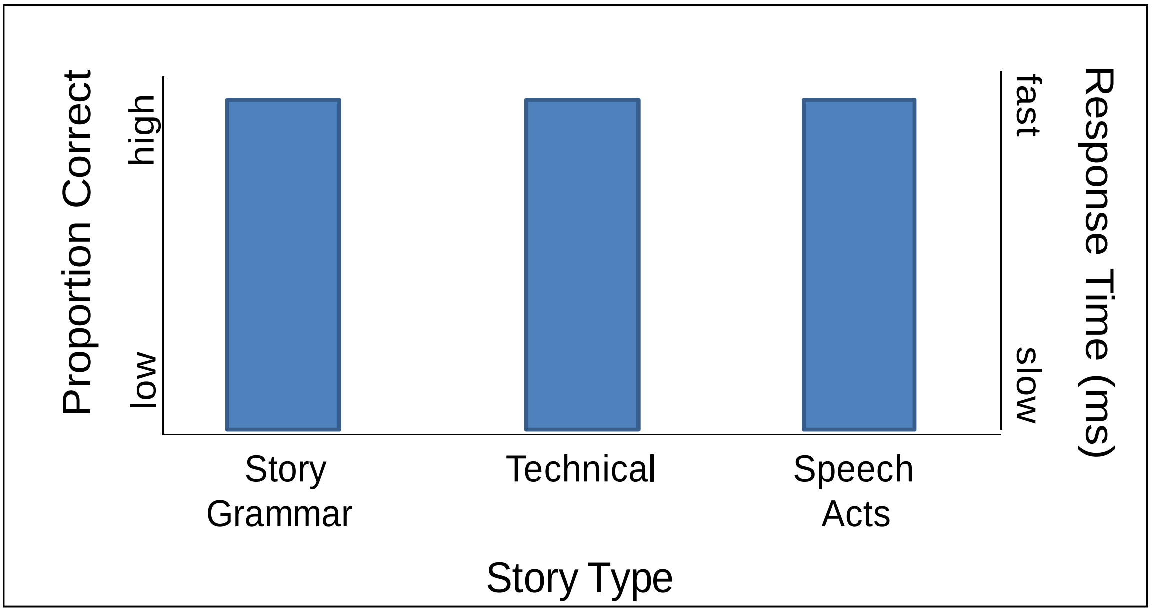
The aim of this study is to reveal the fundamental properties of stories. Are stories a specific kind of schema? If so, the underlying structure of a story would be the component that facilitates communication and memory. If the content of the story is what makes it memorable, then the structure would not be enough. In particular, when people read stories with conversation, they are utilizing expectations that come from speech acts, (e.g., the validity and completeness of the information discussed). The following study examined how and why stories facilitate memory of technical content.

To tease apart possible reasons for why stories are memorable, three different types of stories were used. One type of story, based on story grammar principles has basic components identified by story grammarians (e.g., Mandler, 1984; Stein & Policastro, 1984) such as an animate protagonist, reactions from the protagonist, a causal sequence, and an ending or resolution. Another type of story used these same grammar components but dialogue was inserted into the story so that the information was relayed though conversation. This story draws on speech act theory, which identifies conversations as complex interactions that provide implicit information in the familiar patterns of problem/response or assertion/confirmation-denial. If more information is implicitly available, the reader of the conversations should be able to glean more knowledge about the discussed situation. A third type of story analyzed here was a story with the story grammar components but instead of adding only conversation to the story, information from a technical manual also supplemented the story. The speech act story and the technical story were comparable so that many of the conversations in the speech act story were replaced with technical information about the same subject matter.

According to story grammar theory, a story is defined by its components and the number of components is what makes a story memorable (e.g., Mancuso, 1986; Stein & Policastro, 1984). If different stories have the same number of components, story grammarians predict that the memorability of those stories would be equivalent. Those arguing for a more holistic approach to stories would not agree with this assessment. In the minds of those advocating a holistic approach to stories, there is more to stories than the additive effect of different story components. One way to illustrate this point is to keep the structure of a story but change things that would not necessarily be differentiated by story grammars such as conversations and technical material. One way to measure memorability of a story is to look at proportion correct on a test. Similarly, how fast participants respond to questions about the story also may reflect comprehension. If story grammar theory suggests there is no difference, the response time to questions would be the same across story type (see Figure 1).

Figure 1

Predicted Performance for True and False Responses Based on Story Grammar Research



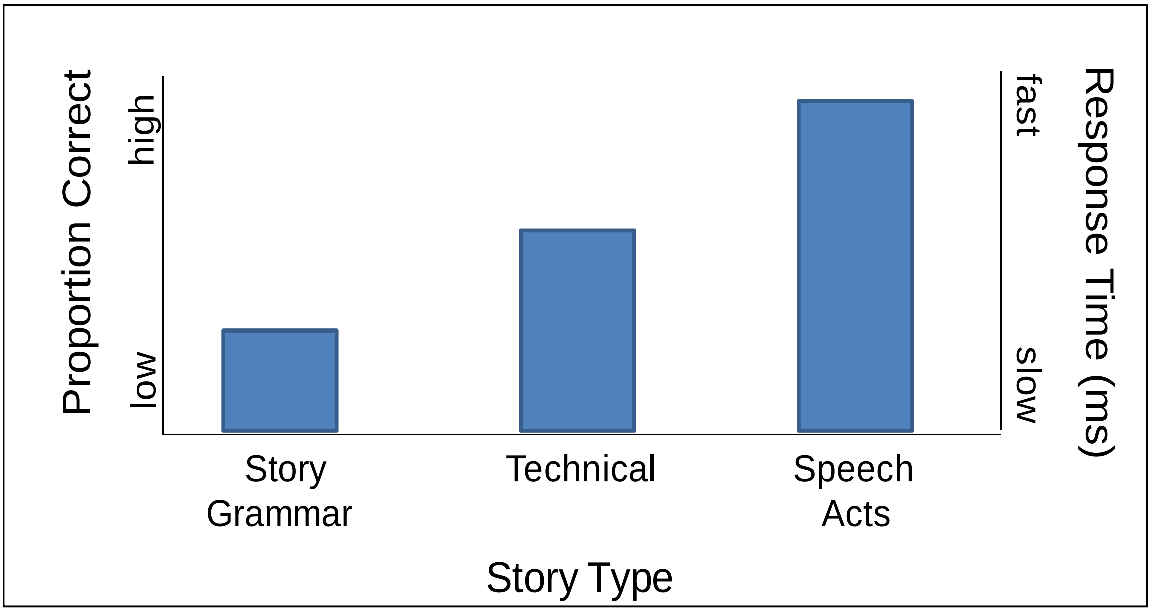
Speech act theory might be extended to suggest that the additional information available in conversations would aid the memorability of the stories above and beyond what could be gained by the components of a grammar. The added implicit information should then increase the understanding of the material discussed. If the conversations were taken away and substituted with causal and temporal technical material, as they were in the technical versions of the scenarios used here, two outcomes could be predicted.

According to a version of basic cognitive theory, the match between the learning material and the performance on the test should determine the quality of the learning material (Morris, Bransford, & Franks 1977). If the text explicitly stated the steps required to perform a repair, then that text should help memory over text that discusses peripheral information about the repair. Therefore, technical stories should have been easier to remember than stories with more conversations. The technical versions of the stories added the same type of information discussed in the other versions of the stories but took some of the conversational information and made it more direct. If the benefit of conversations in stories is simply more information, then it might also follow that making that story-relevant information explicit would aid memory. If the technical information made the implicit information given in conversations more explicit, there would be no need to filter details from a conversation, making it more accessible. It would follow then that the technical versions would be easier to remember than the speech act version with the conversations.

Alternatively, speech act theory would predict that the technical versions would be harder to remember than stories with more conversations (see Figure 2). When the technical stories substituted specific information for the conversational information, they were losing the implicit rules for information exchange. The loss of the implicit understanding that people gained by reading conversations may have hindered memorability of the technical stories. If there were something less tangible being added by conversations than simply an addition of information, then the speech act version of the story would be best. Since the technical versions of the stories have both conversation and expository information (given in a technical manual format), it is possible that the technical versions of the stories would have shown responses in between the speech act versions and the story grammar versions.

Figure 2

Predicted Performance for True and False Responses Based on Speech Act Research[1]



[1]See text for alternative discussion on technical data

This research examines three different types of stories (story grammar, speech acts, and technical) of three different scenarios in split-plot factorial. Each participant saw one story type (story grammar or speech acts or technical) and all three scenarios. The dependent measures were proportion correct and response time to questions about the stories, with the expectation that recently viewed, memorable content or recent inference would be readily available and facilitate response time and proportion correct. Because the participants answered the same questions for each scenario, independent of story type, differences in accessibility across type could not be due to differences in questions. All three story types contain the same number of story grammar components. Therefore, story grammar theory predicts no effect of type. However, speech act theory predicts a facilitation for the speech act type.

Because it is impossible to construct stories that vary as indicated without varying the number of words, length of story was varied with the main effect of story type. Further, the manipulation was potentially confounded with reading level and grade level, which was also similarly varied.

A pilot study was conducted to determine the potential for supporting the hypotheses. The pilot results preliminarily supported the claim that conversationally communicated technical content positively influenced memory. The method and results of the pilot study can be found in Appendix A-D and the stories and questions used in the pilot can be found in Appendix E-G. The results of the final experiment can be found below.

Method

Participants

A total of 219 female undergraduate students from a Midwestern university participated in the following experiment. Sixty two people were removed from the analysis because participants failed to comply with instructions, data exceeded three or more standard deviations above or below the mean, or because data on too many subjects was collected. Those who were removed because of the last condition were all within one standard deviation of the mean for their story type. The final group consisted of 157 participants. Students received course credit for their involvement. Female participants were used to reduce variance in knowledge about the target domain of car repair.

Materials

Three descriptions about different car repair situations were constructed (see Appendix H). There were three types of stories for each scenario. One type of each scenario included the components found in story grammars (SG) and as such had, minimally, a protagonist, a predicament, a reaction by the protagonist, and a resolution to the situation. The next type tested the impact of speech acts (SA). These stories had more conversational interactions between characters in the story while retaining the structure found in the story grammar type. The final type took most of the text in the speech act stories but substituted technical step-by-step instructions for information given in conversation form (ST).

It is impossible to balance everything in the different types of stories and still maintain differences in one version over another. Flesch reading scores, grade levels, type of information, and word counts were adjusted to make the stories as comparable as possible and to uncorrelate the experimental conditions with these other features in all types of the three stories where possible (see Tables 1 and 2). As you can see in Table 1, the story about the overheated car had the fewest words in the speech act story type, the scenario about starting a car had the fewest words in the story grammar version, and the rough engine cover story had the fewest words in the technical version.

Table 1

Word Counts for Stories

	Overheated	Start Problem	Rough Engine
Speech Acts	776	1110	1177
Technical	803	1055	1074
Story Grammar	795	1004	1031

Table 2

Reading Ease Scores and Grade Level for Stories

	Overheated		Start Problem		Tail Light	
	Reading	Grade	Reading	Grade	Reading	Grade
Speech Acts	79.8	5.3	83.8	4.2	91.9	4.0
Technical	81.2	4.8	79.1	5.0	91.4	3.4
Story Grammar	76.2	6.6	84.7	5.0	87.9	4.9

Note. Read ease and grade levels come from Flesch reading scores.

Higher scores on the Flesch reading ease scale means the text is easier to read.

Participants answered 30 true/false questions, 10 for each of the stories (see Appendix I). Just as word counts, grade levels, and reading ease scores were compared in the stories, the questions were also scored (see Tables 3-6). Though the reading scores were examined on the questions, the criteria for balancing the questions was the number of syllables in the second half of the question. This was done to balance the reading time to give more accurate response time data. Half of the questions were true and half were false. Scenarios were printed on white paper. Questions appeared on a computer screen and answered with key strokes.

Each question a participant might have seen had a true and a false version. The true and false questions were split into two different sets of questions called ‘versions.’ Participants received 5 true questions for each story and 5 false questions for each story. In version 1, they saw the first half of the true list of questions and the 2nd half of the false questions. In version 2, they saw the 2nd half of the true questions for each story and the

1st half of the false questions. The experiment was run once with version 1 questions and replicated using the version 2 questions.

Table 3

Reading Ease Scores and Grade Level for Questions

	True responses		False responses	
	Reading Ease	Grade	Reading Ease	Grade
Overheated	78.7	5.3	84.8	4.6
Start Car	74.2	6.1	83.7	5.0
Rough Engine	92.0	3.6	94.1	3.5
Combined	81.7	5.0	87.6	4.3

Note. Read ease and grade levels come from Flesch reading scores.

Higher scores on the Flesch reading ease scale means the text is easier to read.

Table 4

Reading Ease Scores and Grade Level for Questions by Version

	Version 1		Version 2	
	Reading Ease	Grade	Reading Ease	Grade
Overheated	82.0	4.9	81.7	4.9
Start Car	75.9	6.0	82.3	5.1
Rough Engine	92.1	3.6	94.1	3.4
Combined	83.3	4.8	86.1	4.5

Table 5

True Items - Reading Ease Scores and Grade Level for Questions

	Version 1		Version 2	
	Reading Ease	Grade	Reading Ease	Grade
Overheated	78.5	5.4	79.0	5.2
Start Car	75.6	6.2	72.4	6.1
Rough Engine	89.7	4.1	94.5	3.0
Combined	81.3	5.2	82.0	4.8

Table 6

False Items - Reading Ease Scores and Grade Level for Questions

	Version 1		Version 2	
	Reading Ease	Grade	Reading Ease	Grade
Overheated	85.4	4.5	84.3	4.7
Start Car	76.1	5.8	90.0	4.4
Rough Engine	94.7	3.2	93.5	3.8
Combined	85.4	4.5	89.5	4.2

In addition to the three experimental groups that read the speech acts, technical, or story grammar story types, a control condition was run. In the control condition, participants did not read the stories but did answer the questions. The control condition also was separated by version.

All participants saw 30 true/false questions, 10 for each scenario. Participants also saw 3 qualitative questions at the end of each set of 10 questions (Appendix J). These open-ended questions allowed participants to type their responses.

Finally, participants answered a survey on their perceived experience with car repair (Appendix K). This paper survey was completed after the participant had finished with the computer questions.

Design

This research used a 4x2x6x3 split plot with story type (control, speech acts, technical, or story grammar), version (1 or 2), and order as between subjects, and cover story (Overheated Car, Start Car, and Rough Engine) as a within subjects variable.

Procedure

Participants were run in a computer classroom so that up to 17 people participated at the same time. Each sat at their own computer desk with their own copies of the stories. Participants read three stories, all of the same type. For example, a participant read the story grammar version of the overheated car scenario, the start car scenario, and the rough engine scenario. After reading the three scenarios, they set them aside. Participants did not have a time limit for reading the scenarios. They then answered 30 true false questions on a desktop computer. Instructions for the questions were displayed on the computer screen and were as follows: "Read and answer the following true/false questions about the stories you just read. Give the best answer based on knowledge you picked up from the stories." Participants indicated agreement with the statements by pressing G, and disagreement by pressing H. The presentation of the questions was random within the block of 10, but each set of 10 reflected the order in which they read the stories. If the participant read about the overheated car first, they would answer all 10 questions about that scenario first. After they finished the computer questions, they completed a paper-based questionnaire asking them about their experience with car repair (Appendix K). The experiment lasted approximately 30 minutes.

Measures

The time participants took to respond to the questions was recorded as well as their accuracy in answering the questions. Qualitative open-ended questions appeared at the end of the true/false questions and subjects typed their responses. A paper survey measured self-reported experience with car repair and was filled out after the participant finished the computer portion of the experiment.

Results

Measures

Response time measures consisted of the mean response time in milliseconds per participant. Incorrect answers were excluded from the analysis, as were outliers. The remaining answers were averaged together for one single score per participant per story. True response times consisted of the averaged response times from the 5 possible true questions per story. The same occurred for the false response times so that a score for true questions and a score for false questions was gathered from each participant for each story. The response times for the true and false questions were analyzed separately as well as together.

Analysis Method

Statistical analyses proceeded as follows. Initially an ANOVA with all variables was run with the three story conditions and the control condition. If the ANOVA was significant, a t test was conducted to compare the control group to the average of the other three conditions (story conditions). Correlational analyses were also run to look for any covariates. After ANOVAs were run, the dependent measures in question were compared to the correlation matrix. If a covariate was found involving the measures analyzed, the covariate was removed from the dependent measure and an adjusted score was rerun as a new adjusted dependent measure.

If the ANOVA analysis included a comparison between the control group and story conditions, an additional test called a Dunnett test was conducted. This analysis was conducted as a planned comparison even if the original ANOVA was not significant.

Analyses then were run on only those who were in the story conditions. The correlational data is presented first followed by the results of the ANOVAs. If the ANOVA was significant, t tests were run comparing the speech acts stories with the other two conditions, and then comparing the story grammar stories with the technical condition. After these orthogonal tests were run, another set of t tests were run comparing the technical condition with the speech acts stories and with the story grammar stories. Correlational analyses were run on this group to the same end as the analyses mentioned above that included the control condition.

Following the analyses of the variables of interest in this experiment, preliminary analyses describing the sample will be described to examine sampling artifacts.

Analyses with Control

Correlational analysis. Correlational analyses for all participants (control and experimental) included order, experience measures, and average values for proportion correct, total response time, response time for trues, and response times for falses, Table 7. Several expected significant correlations appear among the dependent measures. Response time measures are interrelated and were appropriately correlated. The qualitative measures were positively correlated with response time measures suggesting they both reflected ability to answer the questions appropriately. Experience measures were interrelated suggesting they all measured perceived experience with car repair.

The correlational analysis indicates no relationship between self-reported general experience (in the left most column) and response time for the data set including control participants. However, this analysis suggested a positive correlation between general experience and average proportion correct, $r = .24$, $p < .01$. Those with more self-reported experience had a higher proportion correct score. This result will be explored in the section regarding sampling issues.

Table 7

Correlational Analyses Including 4 groups (1 control and 3 story types)

	Dependent Measures					Experience Measures		
	Total RT	False RT	True RT	PC	Qual	OExp	Sexp	GExp
Total	--	.71**	.70**	-.13	-.17*	-.07	-.02	-.06
False		--	.69**	-.13	-.24**	-.13	-.10	-.08
True			--	-.07	-.29**	-.11	-.04	-.08
PC				--	.49**	.14	.25**	.24**
Qual					--	.22**	.28**	.34**
OExp						--	.55**	.60**
SExp							--	.47**
GExp								--

Note.

Total = all response times

False = false response times

True = true response times

PC = proportion correct

Qual = qualitative answers

OExp = perceived prior experience with an overheated car

SExp = perceived prior experience with a car that won't start

GExp is perceived prior experience with general car repair

N = 157

* $p < .05$

** $p < .01$

Proportion correct for three story types plus control. A series of analyses showed that those who read the stories were able to answer more questions correctly than those who did not read the stories. A split-plot ANOVA was run (between variables: story type, version, presentation order, and within variable: cover story) with proportion correct as the dependent variable. The data showed that learning depended on story type condition, Table 8, $F(3, 153) = 21.70$, $p < .0001$. Specifically, those who read the stories scored better on the questions than did those who did not read the stories, $t(153) = 7.9$, $p < .05$, Table 9. Also, a Dunnett test at $p = .05$ showed that speech acts, story grammar, and technical conditions together ($M = .811$, $MSE = .02$) were significantly different than the no story condition ($M = .692$, $SE = .02$, critical Dunnett = .090).

Table 8

Proportion Correct

	M	*SE*
No Story	0.692	0.02
Speech Acts	0.835	0.01
Story Grammar	0.801	0.01
Technical	0.797	0.01

Table 9

Proportion Correct – t test analysis

	M	*SE*
No Story	0.692**	0.02
Avg of Story Conditions	0.811	0.01

Note. ** p < .01

Response time for three story types plus control. Response time data were analyzed by examining the average response times for the subject as well as separating out the response times for the questions that should have been answered true and those that should have been answered false. Within subjects nuisance variables such as interactions with order are not of interest in this experiment so sphericity tests were generally irrelevant. Further, none of the dependent variables showed a violation of sphericity.

A split-plot ANOVA with response time as the dependent variable and all independent variables was run (between variables: story type, version, presentation order, and within variable: cover story). The average response times for those who did not receive the stories (control) was no different than those who did read the stories, $F(3, 109) = 2.18$, $p = .09$, See Table 10. For a full ANOVA. For a full ANOVA table, see Appendix L, Table 46. A Dunnett test at $p = .05$ is consistent with this result, (Story Type $M = 2910.07$, $MSE = 1113915.8$; Control $M = 3027.64$, $SE = 82.52$, critical Dunnett = 630.37).

Table 10

Story Type and Total Response Time

	M	*SE*
No Story	3027.64	82.52
Speech Acts	2757.81	74.61
Story Grammar	3083.81	79.84
Technical	2888.58	62.67

Note. Response times in milliseconds

Summary Chart of Analyses with Story Conditions and Control Conditions

A list of the main and interaction effects for the four story conditions (3 story types and the control condition) can be seen in Table 11. The sources for the split-plot ANOVA are along the top. Labels in the rows show dependent measures. The table is split so that between subject effects are on the left and within subject effects are on the right.

Table 11

Main Effects and Interactions Including Story Conditions and Control

Dep Meas	Stype: NS SA ST SG	Ver	Cover	Order	Ver x Stype	Ver x Order	Cover x Stype	Cover x Order	Cover x Ver	Order x Stype	Cov x Ord x Stype	Ver x Ord x Cov	Ver x Ord x Styp	Ver x Ord x Cov x Stype
Total	2.18	4.03*	0.90	0.70	1.13	1.89	1.36	19.10**	4.07	1.65	1.03	1.62	0.92	0.86
True	1.21	2.55	0.19	0.52	2.70	2.59*	1.95	11.90**	2.30	1.90*	0.80	1.23	0.86	0.76
False	2.14	4.62*	2.42	0.72	0.59	1.96	1.25	9.01**	2.32	1.15	1.49	1.18	0.79	1.06
Pr Ct	21.70**	0.61	17.98**	1.59	2.01	0.82	1.06	1.08	25.22	0.92	0.93	0.55	0.61	0.63

Note.

F ratios for Between Subjects effects have an error term with df = 109

SA = Speech Acts

ST = Technical

SG = Story Grammar

Ver = Version

Stype = Story Type

Ord = Presentation Order

Cov = Cover

Pr Ct = Proportion Correct

* p < .05

** p < .01

Analyses with Story Conditions Only

Correlational analyses with three story types. Correlational analyses of just the three story conditions were run on the data set to find potential covariates. Separate correlational analyses for participants in the story conditions permitted an examination of story variables (reading level, word count, and grade level of the stories) along with self-reported experience with overheated car, start car, and general experience with cars, true, false, and total response times for each of the stories, and qualitative answers. Table 12 shows correlations between dependent measures. From left to right, the table shows correlations with response time measures, proportion correct, and then qualitative responses. The next group shows correlations with the self-reported experience measures. The last group on the far right shows covariates in the form of readability measures of the stories.

Response time measures correlated with other response time measures as was the case with the correlations of the no-story group. In the story groups, experience measures did not significantly correlate with other measures, though in the no story group, experience with an overheated car was related to response time measures. In the story conditions, proportion correct was correlated with experience measures though this was not the case in the no story group. The analysis also showed that some of the story specific covariate variables were correlated with the dependent measures, Table 12. The dependent measure proportion correct showed correlations with story word count, reading level, and grade level. Qualitative questions were also correlated with grade level. Further, word count, reading, and grade level of the stories were correlated with each other.

Table 12

Correlations with Story Conditions Only

	Dependent Measures				Experience Measures			Story Measures		
	False	True	PC	Qual	OExp	SExp	GExp	WC	Read	Grade
Total	.86**	.87**	-.09	-.18	-.07	-.07	-.07	-.04	-.00	.09
False	--	.53**	-.11*	-.20*	-.07	-.10	-.05	.00	.05	.04
True		--	-.07	-.12	-.03	.00	-.05	-.08	-.04	.10
PC			--	.41**	.11*	.17**	.12*	-.14**	-.21**	.14**
Qual				--	.24*	.25**	.27**	-.11	-.11	.23*
OExp					--	.64**	.63**	.03	.02	-.00
Sexp						--	.48**	.03	.02	-.01
GExp							--	.03	.02	-.01
WC								--	.73**	-.72**
Read									--	-.83**
Grade										--

Note.

Total = all RT

False = false RT

True = true RT

PC = proportion correct

WC = word count of the stories

Read = reading level of the stories

Grade = grade level of the stories

Qual = qualitative answers

OExp = perceived prior experience with an overheated car

SExp = perceived prior experience with a car that won't start

GExp is perceived prior experience with general car repair

N = 108

* $p < .05$

** $p < .01$

*Proportion correct with three story types***.** Analyses were run on only those who read the stories, excluding the control participants who did not. A split-plot ANOVA was run with proportion correct as the dependent variable and story type, version, and presentation order as between variables, and cover story as the within independent variable. The proportion correct data did not show a significant difference between those who read the different story types, $F(2, 72) = 2.19$, $p = .12$, Min .40, Max 1.00. For a full ANOVA table, see Appendix L, Table 47.

Proportion correct with three story types adjusted. The above correlational analysis, Table 12, showed that proportion correct covaried with reading level, word count, and grade level. Additional analyses were run to factor out the influence of the covariates on proportion correct. Reading level accounted for the most variance, $R^2 = .044$, Table 12, so this effect was removed from the proportion correct data by an initial regression of proportion correct on story reading level. When reading level was controlled for in this manner, residual proportion correct for story type became significant, $F(2, 72) = 3.52$, $p = .03$, Table 13. For a full ANOVA table, see Appendix L, Table 48. This analysis shows that after adjusting for reading level, the number of questions answered correctly in the different story type conditions related to the conditions. Analyses with t tests showed that after the adjustment for reading, speech acts was better than story grammar and technical, $t(72) = 2.25$, $p < .05$. Technical did show significantly different results when compared to speech acts, $t(72) = 2.25$, $p < .05$, but not story grammar, $t(72) = .09$, $p > .05$.

When reading adjusted proportion correct was regressed on word count (an additional covariate significantly related to proportion correct), the result was not significant, $R^2 = .000194$, $F(1, 322) = .06$, $p = .81$. The lack of significance is consistent with the correlations between reading ease, word count, and grade level found in Table 12. A graph of the adjusted proportion correct data after an additive transformation can be seen in Figure 3.

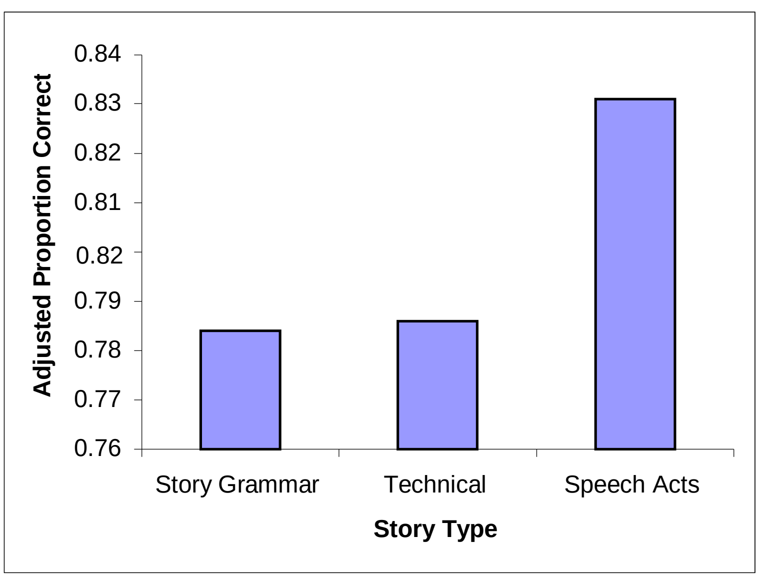
Table 13

Proportion Correct – Adjusted for Reading Level

	M	*SE*
Speech Acts	0.031	0.012
Story Grammar	-0.016	0.013
Technical	-0.014	0.013

Figure 3

Adjusted Proportion Correct after additive transformation



Analyses with Story Conditions Only Continued – Response Times

Split-plot ANOVAs on response time for the story conditions included all independent variables (between variables: story type, version, presentation order, and within variable: cover story).

Total response times for three story types. Total response times with only the story conditions showed that participants responded differently to the different story types, $F(2, 72) = 3.15$, $p = .049$, Min 1526ms, Max 5264ms, See Table 14, Figure 4. For a full ANOVA table, see Appendix L, Table 49. Response times for the speech acts condition were significantly faster than the response times of the story grammar and technical conditions, $t(72) = 2.47$, $p < .05$. Technical was not significantly different from speech acts, $t(72) = 1.00$, $p > .05$ or story grammar, $t(72) = 1.49$, $p > .05$.

Table 14

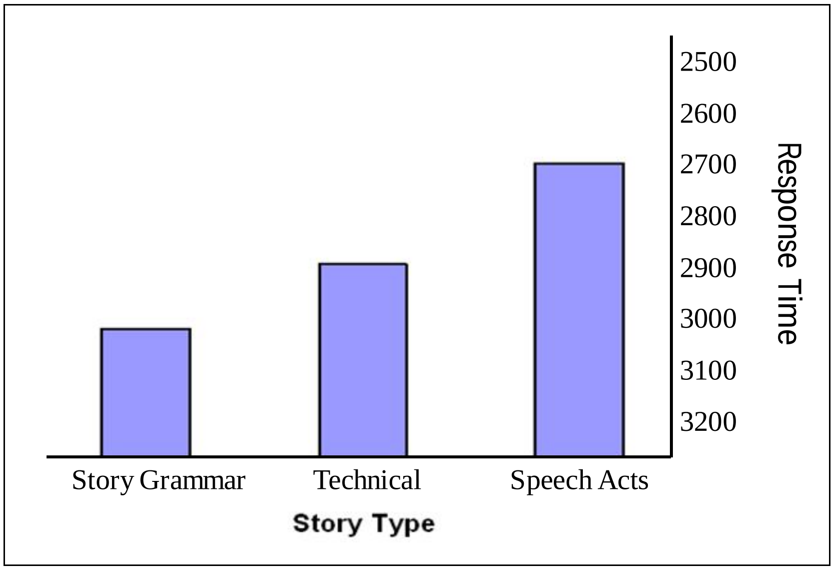
Total Response Time by Story Type

	M	*SE*
Speech Acts	2757.81	74.61
Story Grammar	3083.81	79.84
Technical	2888.58	62.67

Note. Response time in milliseconds

Figure 4

Response Time by Story Type



Note. Response time in milliseconds

Y axis is flipped to echo the structure found in Figure 2

The total response times (above) included response times from both true and false questions. The response times for each were also analyzed separately. The average RT for false questions was 2980.45ms (*SE* 52.73). The average response time for true was 2865.41ms (*SE* 48.33). The confidence intervals for true and false response times overlap as indicated in Tables 15 and 17. Additionally, the difference between the true and false means for the speech act story type was approximately 1 millisecond. A one-tailed independent z test on the response time means for the three conditions just misses significance, $z = 1.61$, $p > .054$. Although this preliminary analysis provides scant evidence for a difference between true response times and false response times, because the underlying process for answering falses could potentially be different from the underlying process for answering trues, the response times were analyzed separately as well as together.

False response times for three story types. The split-plot ANOVA for false response times included all independent variables (between variables: story type, version, presentation order, and within variable: cover story). The response times for the speech acts story type were significantly faster than the times for the story grammar and technical conditions, Table 15, $F(2, 72) = 3.35$, $p = .041$; $t(72) = -2.74$, $p = .008$; Min 1596ms, Max 5961ms. Technical was not significantly different than speech acts, $t(72) = 1.29$, $p = .201$, or story grammar, $t(72) = 1.30$ $p = 1.98$. False response times also showed a main effect of version, $F(1, 72) = 5.11$, $p = .027$, Table 16.

*False response time interactions with nuisance variables***.** Falses showed an interaction with cover by presentation order, $F(10 ,72) = 7.52$, $p < .0001$, and cover by presentation order by story type, $F(20, 72) = 1.90$, $p = .02$.

Table 15

False Response Times

	M	*SE*	CI Lower	CI Upper
Speech Acts	2769.09	85.47	2601.57	2936.61
Story Grammar	3192.52	98.31	2999.83	3385.21
Technical	2979.74	85.88	2811.42	3148.06

Note. CI = 95% Confidence Interval

Table 16

False by Version

	M	*SE*
Version 1	2829.48	89.54
Version 2	3131.42	91.08

True response times for three story types. This split-plot ANOVA included all independent variables (between variables: story type, version, presentation order, and within variable: cover story).

True response time main effects. True response times did not have any significant main effects (See Table 17 for story type means). In particular, the response times were not significantly different for story type, $F(2, 72) = 1.76$, $p = .18$; Min 1393ms, Max 5193ms. Neither were there any significant covariates, therefore no adjustments were made.

Table 17

True Response Times by Story Type[1]

	M	SE	CI Lower	CI Upper
Speech Acts	2770.49	89.20	2595.66	2945.32
Story Grammar	3014.90	92.02	2834.54	3195.26
Technical	2810.84	66.40	2680.70	2940.98

[1]Not significant

Note. CI = 95% Confidence Interval

Interactions between story type and nuisance variables for true responses. True responses showed an interaction with version by story type, $F(2, 72) = 4.32$, $p = .02$, Table 18, Figure 5, presentation order by story type, $F(10, 72) = 2.36$, $p = .02$, Table 19, and presentation order by cover, $F(10, 72) = 11.97$, $p < .0001$, Table 20.

To explore the interactions with the true responses, separate split-plot ANOVAs examined the effects of story type, presentation order, and cover for each version separately. A split-plot ANOVA with story type and presentation order as the between variables and cover as the within variable revealed a significant relationship between story type and true RT for version 1, $F(2, 108) = 10.17$, $p < .0001$. However, the true RTs showed no effect of story type for version 2, $F(2, 108) = 1.67$, $p = .19$.

Table 18

True Response Times of Story Type by Version

	Version 1	Version 2
Speech Acts	2429.56	3111.41
Story Grammar	3064.14	2965.65
Technical	2777.31	2844.36

Note. Response times in milliseconds

Figure 5

True Response Times by Version

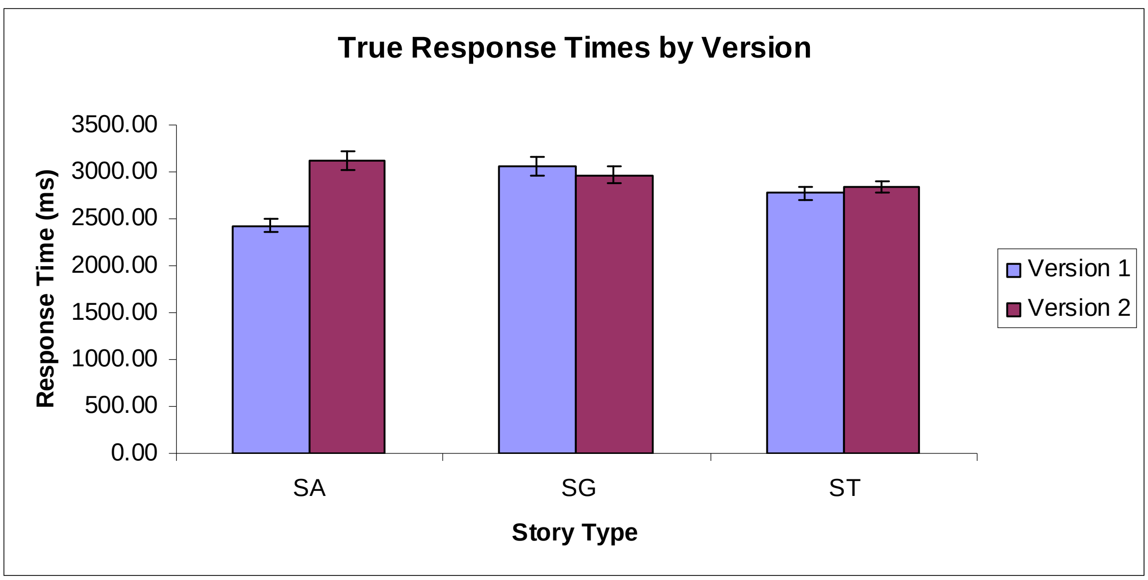


Table 19

Presentation Order by Story Type for True Response Times

Order	Story Type	MEAN	SE
1	Speech Acts	2971.16	106.16
1	Story Grammar	3180.39	83.29
1	Technical	2649.24	61.42
2	Speech Acts	2977.67	87.35
2	Story Grammar	3272.43	103.26
2	Technical	2445.20	69.83
3	Speech Acts	2960.86	79.32
3	Story Grammar	3000.06	115.62
3	Technical	2871.15	52.45
4	Speech Acts	2297.20	65.98
4	Story Grammar	3593.32	82.28
4	Technical	3164.37	67.28
5	Speech Acts	2927.67	110.53
5	Story Grammar	2472.51	58.38
5	Technical	2822.09	66.73
6	Speech Acts	2488.37	62.67
6	Story Grammar	2570.66	55.98
6	Technical	2912.98	66.60

Table 20

Presentation Order by Cover for True Response Times

Order	Cover	MEAN	SE
1	Overheated car	3387.96ms	98.32
1	Rough Engine	2654.37ms	69.54
1	Start Car	2758.46ms	76.11
2	Overheated car	3692.50ms	99.75
2	Rough Engine	2619.05ms	64.02
2	Start Car	2383.75ms	54.99
3	Overheated car	2655.82ms	88.40
3	Rough Engine	3207.42ms	62.48
3	Start Car	2968.83ms	96.32
4	Overheated car	2771.51ms	62.50
4	Rough Engine	3497.87ms	94.39
4	Start Car	2785.51ms	89.44
5	Overheated car	2806.68ms	101.35
5	Rough Engine	2555.11ms	72.41
5	Start Car	2860.49ms	71.80
6	Overheated car	2243.23ms	55.33
6	Rough Engine	2778.39ms	49.57
6	Start Car	2950.39ms	65.63

Summary of Analyses with Story Conditions Only

A list of the main and interaction effects for the three story conditions can be seen in Table 21. The sources for the split-plot ANOVA are along the top. Labels in the rows show dependent measures. The table is split so that between subject effects are on the left and within subject effects are on the right.

Table 21

Main Effects and Interactions of Story Conditions

Dep. Meas.	Stype: SA ST SG	Ver	Cover	Order	Ver x Stype	Ver x Order	Cover x Stype	Cover x Order	Cover X Ver	Order x Stype	Cov x Ord x Stype	Ver x Ord x Cov	Ver x Ord x Styp	Ver x Ord x Cov x Stype
Total	3.15*	4.98*	2.25	1.55	1.69	1.05	0.97	16.33**	2.90	1.79	1.31	1.33	1.37	0.81
True	1.76	3.61	0.54	0.96	4.32*	1.48	1.27	11.97**	2.31	2.36*	1.29	0.93	1.24	0.70
False	3.35*	5.11*	1.23*	1.59	0.67	1.62	0.42	7.52**	1.91	0.89	1.90*	0.89	1.03	1.14
PC	2.19	0.02	11.44**	1.33	1.51	0.78	0.91	1.02	23.11**	0.87	0.67	0.64	0.31	0.37
PC cov R	3.52*	0.02	0.58	1.33	1.51	0.78	0.72	1.02	23.11**	0.87	0.67	0.64	0.31	0.99

Note.

F ratios for Between Subjects effects have an error term with df = 72

PC cov R = Proportion correct after removing the effect of reading level

SA = Speech Acts

ST = Technical

SG = Story Grammar

Ver = Version

Stype = Story Type

Ord = Presentation Order

Cov = Cover

PC = Proportion Correct

* p < .05

** p < .01

Influence of Version on Response Times

To explore the differences between the versions for the true responses, an overview of the content of the true questions was done, see Tables 21-22). Questions from each version were categorized according to whether they appeared in the conversation part of the text, the exposition part of the text, or the technical part of the text. Conversations referred to text that included quotation marks. Technical information was defined as text where the information was indicated to be from a manual. Exposition was defined as places where the majority of the text did not include conversations or technical information. The content review showed an imbalance in the type of text the questions were pulled from. Version 1 trues contained fewer conversation questions than those in version 2.

Table 22

Content Analysis of Questions from Stories Version 1

Version 1	Conversation	Exposition	Technical
Speech Acts	8	7	0
Story Grammar	0	15	0
Technical	3	4	7

Note. Number of questions taken from each portion of the stories - version 1

Table 23

Content Analysis of Questions from Stories Version 2

Version 2	Conversation	Exposition	Technical
Speech Acts	12	3	0
Story Grammar	0	15	0
Technical	3	2	10

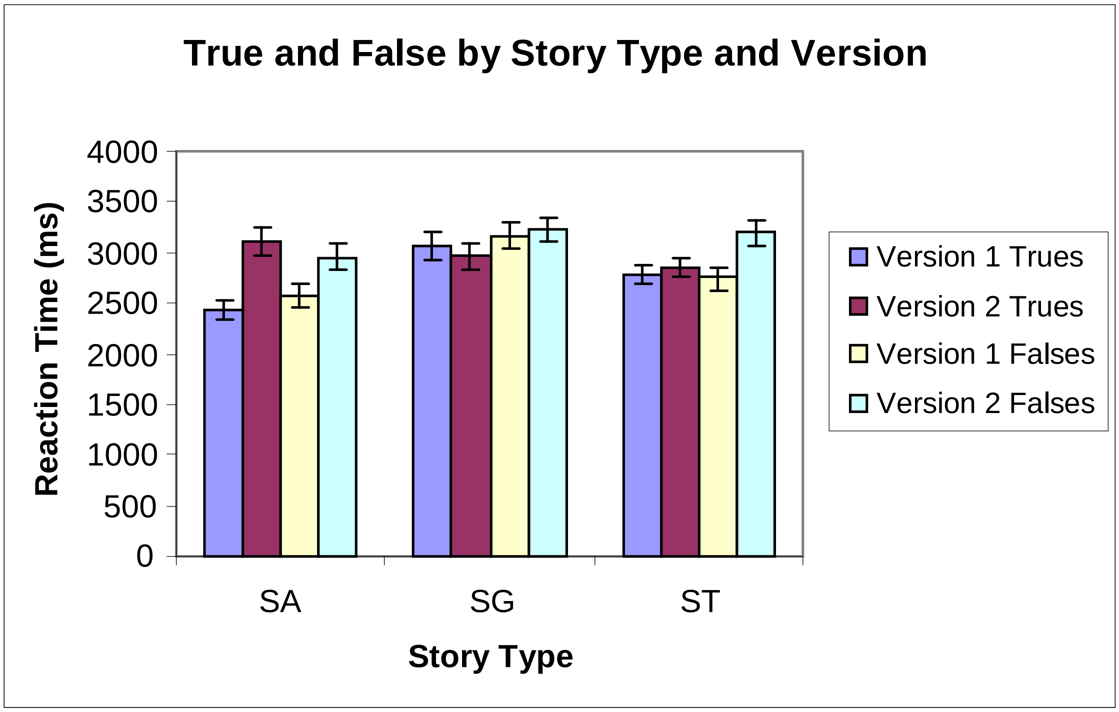
Note. Number of questions taken from each portion of the stories - version 2

True vs. False in Same ANOVA

The above analyses indirectly addressed the question of whether true response times differed from false response times, primarily by modeling each type of response separately. To address the question more directly a split-plot ANOVA was conducted with story type, order, and version as between subject variables, and answer type and cover story as within-subject variables, see Tables 50-51 in Appendix L for means, full ANOVA in Table 52, Appendix L. This failed to yield a story type main effect, but instead shows an answer type * story type * version effect. The means and standard errors for this effect appear in Figure 6 below. To address the need for modeling true response times separately from false response times, true and false response times for each version * story type combination were compared. Speech acts true and false response times were equal in both version 1 and version 2, $t(72) = 1.14$ and -1.16 respectively. Story grammar and technical true and false response times were the same in version 1, $t(72) = .65$ and -.14 respectively, and differed in the expected direction in version 2, $t(72) = 2.04$ and 2.69 respectively.

Figure 6

ANOVA with True and False questions



Essential vs. Non-Essential

The stories included information that could be considered essential to the repair and less essential to the repair. A question was considered essential if the action it described referred to the actual execution of the procedure. The questions were similarly classified and analyzed accordingly. A split-plot ANOVA was run with all independent variables (between variables: story type, version, presentation order, and within variable: cover story). The differences between the response times to essential questions was not significant for story type, $F(2, 72) = .11$, $p = .89$, See Table 24. The same split-plot

ANOVA was run with the less essential questions as the dependent variable. Differences between the response times to the less essential questions was also not significant for story type, $F(2, 72) = 2.87$, $p = .06$ See Table 25. This arrangement of the questions did not yield significant results.

Table 24

Essential

	M	*SE*
Speech Acts	2832.60	108.41
Story Grammar	2906.27	105.10
Technical	2893.57	91.54

Table 25

Less Essential

	M	*SE*
Speech Acts	2754.01	120.33
Story Grammar	3121.83	129.27
Technical	2763.47	90.20

Qualitative Questions

Participants answered qualitative questions for each story (e.g., Why would putting a cool liquid in a warm car be a problem?). Each story had three questions. Each question could receive a 0, 1 or 2. Subjects received a score of 2 when they answered correctly and demonstrated knowledge from the stories. Subjects received a score of 1 if they gave an answer that appeared to be on the right track, but did not fully answer the question. Subjects were given a score of 0 if they gave the wrong answer, if they did not answer, or if they answered too succinctly (e.g., if their answer was "because"). Each subject had the possibility of 18 points across all three cover stories. Two raters scored each response, until 99% agreement was obtained. To create a continuously valued dependent measure, cover story was dropped from the analysis and total qualitative scores were used in the analysis. The split-plot ANOVA for qualitative questions included all independent variables (between variables: story type, version, presentation order). The qualitative scores for the different story types were significant, $F(2, 72) = 4.35$, $p = .02$, Table 26, Min 0, Max 18.

Qualitative Questions and Covariates

The correlation tables above, Table 12, showed a significant relationship between qualitative questions and the story variable grade level, $r = .23$. To follow up on this result, the qualitative questions were regressed on grade level. When grade was factored out of the qualitative result, the significant relationship between story type and the qualitative answers disappeared, $F(2, 72) = .82$, $p = .45$, Table 27.

Table 26

Qualitative Item Scores

	M	*SE*
Speech Acts	10.861	0.38
Story Grammar	12.028	0.36
Technical	9.667	0.34

Note. Qualitative scores in this table were aggregated across all answers to collapse cover story. Scores are additive

Table 27

Qualitative Item Scores Adjusted for Grade Level

	M	*SE*
Speech Acts	10.034	0.38
Story Grammar	9.452	0.36
Technical	9.015	0.34

Summary of Analyses with Qualitative Measures

A list of the main and interaction effects the qualitative measures can be seen in Table 28. The sources for the split-plot ANOVA are along the top. Labels in the rows show dependent measures. The table is split so that between subject effects are on the left and within subject effects are on the right.

Table 28

Qualitative Main Effects and Interactions

	Story type	Version	Order	Version x Story type	Version x Order	Order x Story type	Ver x Ord x Styp
Qual 4 story types	30.32	4.71*	1.22	1.56	1.16	1.47	1.32
Qual 3 story types	4.25*	3.28	1.74	2.45	1.26	1.77	1.38

Note. F ratios for Between Subjects effects with 4 levels of story type have an error term with 109 df

F ratios for Between Subjects effects with 4 levels of story type have an error term with 72 df

Qual = Qualitative

Stype = Story Type

Ord = Presentation Order

* $p < .05$

** $p < .01$

Descriptive Analyses

Tables 29-33 present descriptive statistics for all of the experimental variables collected for subjects in the non-story (control) as well as the experimental conditions. For a full ANOVA table of response times for the control condition only, see Appendix L, Table 53. The skewness measures in the descriptive statistics, Tables 27-31, show that most of the skewness measures were well below +/-1.0 (with the possible exception of the True response times). Therefore, the analyses used raw data.

Table 29

Descriptive Statistics - True Response Times

	Mean	SE	Median	Mode	SD	Var	Kurtosis	Skew	Range	Min	Max	Sum	Count
SA	2770.49	89.20	2643.89	1828.73	927.00	859325	2.02	1.11	5012.85	1202.52	6215.37	299213	108
SG	3014.90	92.02	2856.51	#N/A	956.33	914572	0.86	0.92	4664.02	1452.98	6117.00	325609	108
ST	2810.84	66.40	2755.10	2755.10	690.00	476093	-0.02	0.22	3610.85	1277.69	4888.54	303570	108
NS	2955.18	81.98	2880.69	#N/A	993.96	987963	1.62	0.87	6011.17	1202.52	7213.69	434412	147

Note.

SA = speech acts

SG = story grammar

ST = technical

NS = no story (control)

Table 30

Descriptive Statistics - False Response Times

	Mean	SE	Median	Mode	SD	Var	Kurtosis	Skew	Range	Min	Max	Sum	Count
SA	2769.09	85.47	2664.26	2224.08	888.19	788886	1.18	0.92	4887.31	977.36	5864.66	299062	108
SG	3192.52	98.31	3215.77	#N/A	1021.67	1043807	2.19	0.97	5962.57	1453.15	7415.72	344792	108
ST	2979.74	85.89	2805.11	2730.43	892.54	796636	0.85	0.84	4593.13	1322.71	5915.84	321812	108
NS	3057.51	81.77	3004.50	#N/A	991.45	982975	0.54	0.70	4930.81	1182.55	6113.36	449454	147

Table 31

Descriptive Statistics - Total Response Times

	Mean	SE	Median	Mode	SD	Var	Kurtosis	Skew	Range	Min	Max	Sum	Count
SA	2757.81	74.61	2700.02	2048.37	775.32	601121	0.89	0.80	4250.46	1280.56	5531.02	297844	108
SG	3083.81	79.84	2977.16	#N/A	829.74	688474	0.79	0.73	4521.68	1569.90	6091.58	333051	108
ST	2888.58	62.67	2812.74	2738.65	651.25	424125	-0.25	0.38	2976.62	1620.05	4596.67	311967	108
NS	3027.64	70.73	2980.68	#N/A	857.56	735409	-0.40	0.44	3986.53	1380.81	5367.33	445064	147

Table 32

Descriptive Statistics - Proportion Correct

	Mean	SE	Median	Mode	SD	Var	Kurtosis	Skew	Range	Min	Max	Sum	Count
SA	0.84	0.01	0.90	0.90	0.13	0.02	0.25	-0.74	0.50	0.50	1.00	90.20	108
SG	0.80	0.01	0.80	0.80	0.14	0.02	-0.26	-0.45	0.60	0.40	1.00	86.50	108
ST	0.80	0.01	0.80	0.80	0.14	0.02	-0.34	-0.37	0.60	0.40	1.00	86.10	108
NS	0.69	0.01	0.70	0.80	0.16	0.03	-0.40	-0.40	0.70	0.30	1.00	101.70	147

Table 33

Descriptive Statistics - Qualitative Average

	Mean	SE	Median	Mode	SD	Var	Kurtosis	Skew	Range	Min	Max	Sum	Count
SA	1.21	0.06	1.33	2.00	0.60	0.36	-0.96	-0.18	2.00	0.00	2.00	130.33	108
SG	1.34	0.06	1.33	2.00	0.57	0.32	-0.63	-0.46	2.00	0.00	2.00	144.33	108
ST	1.07	0.05	1.00	1.33	0.55	0.30	-0.60	0.08	2.00	0.00	2.00	116.00	108
NA	0.60	0.04	0.67	0.67	0.51	0.26	0.30	0.78	2.00	0.00	2.00	88.00	147

Note. Table 26 shows additive scores rather than averages as portrayed here

Cohort Similarity in Control Groups

The true and false response time measures showed differing results according to version (version being the specific set of questions asked in the experiment). This pattern of results led to separate analysis of the cohorts for version 1 and version 2.

A split plot ANOVA with version and presentation order as the between subject variables, cover as the within subject variable, and true response times as the dependent variable showed no version effect, $F(1, 37) = .01$, $p = .94$, Min 1203ms, Max 7214ms. The same analysis was run for false response times, $F(1, 47) = .23$, $p = .63$, Min 1183ms, Max 6113ms and general experience, $F(1, 47) = 2.61$, $p = .11$, Min 1, Max 5, with the same result. Proportion correct showed a marginal version effect, $F(1, 47) = 4.02$, $p = .051$, Min .30, Max .10.

Correlations between proportion correct, general experience, and true, false, and total responses times were run with version 1 and version 2 control participants only, Table 34. The table below shows r values of dependent measures. Response time, proportion correct, and responses to qualitative questions on the left, with the three experience measures grouped to the right. This analysis also showed no relevant significant relationships between the experimental dependent measures and self-reported general experience, but the response time measures did correlate with overheated car experience. Notably, the self-rated experience measures did not correlate with proportion correct. The correlational analysis did show a significant relationship between qualitative questions and response times. Those who took less time to answer the questions also tended to answer the qualitative questions correctly.

Table 34

Correlations with No Story (control)

	Dependent Measures				Experience Measures		
	False RT	True RT	PC	Qual	OExp	SExp	GExp
Total	.89**	.84**	.01	-.45**	-.22**	-.03	-.10
False	--	.55**	-.01	-.40**	-.16*	-.01	-.08
True		--	.05	-.45**	-.20*	-.08	-.07
PC			--	-.02	.01	.04	.00
Qual				--	.20	.28	.25
OExp					--	.31**	.55**
SExp						--	.37**
GExp							--

Note.

Total = all response times

False = false response times

True = true response times

PC = proportion correct

Qual = qualitative answers

OExp = perceived prior experience with an overheated car

SExp = perceived prior experience with a car that won't start

GExp is perceived prior experience with general car repair

N = 49

* p < .05

** p < .01

Experience Measures

The experience data consisted of a measure of general car repair and questions relating to experience with the specific car repair scenarios addressed in the stories. One experience measure relating to the rough engine scenario was dropped due to an oversight in the preparation of the subject questionnaires, including an item pertaining to a story that was not included in the study. An additive transformation on the reported experience scale resulted in positive numbers relating to higher perceived experience.

General experience as a dependent measure. Originally the measure of perceived experience with car repair was intended to serve as a way to determine group differences. The data from these survey questions were collected after the participant read the stories and answered the questions. Because of the absence of correlation between experience and proportion correct within the control groups, the relationship between self-reported car experience and the type of story they read is potentially an effect of the story conditions, with the self-reported dependent measure functioning as a manipulation check

To look at the effect of the experience measures in relation to the story conditions and the control condition, a split-plot ANOVA was calculated with general experience as the dependent measure and story type, version, and presentation order as the between variables and cover story as the within variable. Story type predicted self-reported general experience, $F(3, 109) = 4.17$, $p = .0078$, $R^2 = .068$, Min 1, Max 5, Table 35. The relationship between story type and general experience showed that those who did not read the stories reported less car experience than those who read the stories, $t(109) = 3.37$, $p < .01$. However, when a Dunnett test set at $p = .05$ was run, the relationship between story type and general experience was no longer significant, (Story type M =

1.04, untransformed *MSE* = 2.87; Control *M* = .531, *SE* = .07, critical Dunnett = 1.02). Other experience measures were not related to story type, O Experience, $F(3, 109) = 1.39$, $p = .25$, Min 1, Max 5, Table 36; S Experience, $F(3, 109) = 1.83$, *p* .15, Min 1, Max 5, Table 37.

Table 35

Story Type and General Car Experience

	M	*SE*
No Story	0.531	0.07
Speech Acts	1.278	0.12
Story Grammar	0.972	0.11
Technical	0.861	0.10

Note. Experience variables were rated on a 5 point scale

5 being much experience, 1 being little experience.

Table 36

Story Type and Overheated Car Experience

	M	*SE*
No Story	1.163	0.13
Speech Acts	1.639	0.14
Story Grammar	1.278	0.13
Technical	1.028	0.12

Note. Experience variables were rated on a 5 point scale

5 being much experience, 1 being little experience.

Table 37

Story Type and Start Car Experience

	M	*SE*
No Story	1.551	0.12
Speech Acts	2.222	0.13
Story Grammar	1.806	0.14
Technical	1.667	0.12

Note. Experience variables were rated on a 5 point scale

5 being much experience, 1 being little experience.

Discussion

This discussion first addresses the various effects of story type then dismisses potential artifacts in the experiment. The emphasis is on the effect of speech acts versus the story grammar condition, with a secondary concern for the effect of the technical story type.

Recall that participants read stories describing a technical repair on a car. These stories all conveyed the same basic structure but differed in how that information was communicated. Participants then answered questions about those stories. All participants answered the same questions (as either version 1 or version 2) regardless of which story type they read. The differences in how they responded trace back only to the story type they read.

Preliminary Findings

Initially, the results show that participants did learn from the stories. The response time and proportion correct data show that those who read the stories performed better than those who did not. This is an important point as it negates the possibility that the stories conveyed information the participants already knew. The differences found in the dependent measures from those who did not read the stories and those that did show that learning occurred in response to the presence of the stories. The results do not suggest ceiling effects.

Experiment Findings

The next set of analyses discussed here shows that the ability to answer questions correctly about stories was dependent on story type. Those who read the speech acts version of the stories were more accurate and generally faster in their responses than those who read the story grammar or technical versions.

Speech acts versus other story types. The focus of the results and discussion section is on the difference between the speech acts story type and the other two story types (story grammar and technical). The experiment provided three measures, proportion correct, response time, and qualitative answers to questions.

Once the covariate of reading level of the stories was removed, the relationship between proportion correct and story type became significant. Those who read the speech acts version of the story were significantly more accurate than those who read the story grammar or technical versions. Proportion correct therefore suggests there is something more to the ability to answering questions about a story than story grammars suggest. Further, this was a main effect, i.e., not dependent on the particular cover story. The results of the pilot experiment showed an interaction of cover with story type, however, in the experimental data, there was no interaction in the split plot. The replication of the effect in three cover stories and two question sets supported the claim that the effect was not isolated. However, we anticipated that the effect was context dependent, and among other things would be subject to ceiling or floor effects associated with familiarity with the domain.

The pattern of results for total response times also suggested that speech acts is easier than technical and story grammar. Perhaps we are better at reconstructing conversations than other types of text. The constructive nature of our memories (Loftus, 2004) may lend itself to reinventing conversations we've encountered over expository information. Perhaps the structure of conversations allows easier recall because of the reliance on predictable conversation rules (Clark & Brennan, 1991; Clark & Wilkes-Gibbs, 1986; Grice, 2002; Levinson, 1983).

There are different domains where data has suggested we are prewired to approach situations in certain manners. Problem solving literature has shown us that people were better at reasoning about frequency accounts of probable events than proportion accounts of the same (Cosmides & Tooby, 1994). The ability to categorize color perception was also influenced by biological constraints (Berlin & Kay, 1999; Bornstein, Kessen, & Weiskoph, 1976). Cosmides and Tooby (1994) have theorized about the importance of our evolutionary history in how we as humans process information and respond to situations. Perhaps we have a predisposition to understand conversations (speech acts) before information presented in expository form (story grammar). The origins of language in conversations rather than reflections on past events, lends theoretical support to the superior performance associated with the speech acts (Fillmore, 1981). Expository information also involves tense markers that are much less important in conversational text. Story grammar theorists may not have targeted the distinction between conversation and exposition; however, it seemed to represent an influential difference in how people responded to stories.

The results of this experiment call into question the claims of story grammars as the sole explanation for the benefit of comprehension. The presence of story elements is not enough to understand the impact of stories. The results suggest there is more to a story than its components. Each story in the experiment had the same grammar elements across the different story types (speech acts, story grammar, technical), though the results showed that participants responded differently depending on which story type they read. The grammar of a story, held constant across the stimuli clearly did not account for all of the variance; neither could measures of the story such as reading level, grade level, and word count (see Appendix M for further discussion of another story measure). Additionally, the potential pattern of differences across story type cannot be due to differences in the questions because the same questions were used. Similarly, differences in familiarity of the questions are not a possible account for differences across type of story.

Speech act theory can account for the increased understanding when conversations were used. If more information was being communicated by conversations, it follows that people would understand more. It is also possible that it was more than an additional amount of information. Conversation may be a more comprehendible medium for communicating information.

The analysis of true and false response times complicated the findings. Confidence intervals between the true and false response times showed minimal evidence for a difference. However, as there might be differences in processing between true and false questions, these were analyzed separately. False response times echoed the total response times and showed that speech acts was easier than technical and story grammar. Response time to false items was consistent with the results for proportion correct. That is, false response times were faster for those who read the speech acts version than those who read the story grammar or technical versions.

True response times did not follow the pattern of results for the total and false response times and showed no significant main effect for story types. Instead, story type interacted with version. True response times were sensitive to story type in version 1, but not version 2. Version 2 question wording simply reversed the true-false response for version 1 of the questions. Comparison of version 1 and version 2 control conditions failed to reveal any cohort difference. The effect of story type by version suggests that story type has the expected effect for version 1 questions but not for version 2 questions. The questions in version 2 showed no difference between true response times in the story types.

A content analysis on the questions and stories sought to uncover possible differences in the first and second versions of the questions. When identifying what portion of the story the questions came from, a pattern emerged. In version 1, where the response times for true were significant, there were a fairly even number of questions taken from the conversation portions of the text and the expository portions of the text. In version 2, where there was no significant story type difference, more of the questions came from the conversation portions of the text than the expository portions of the text. In version 2, the speech acts response times were not fast enough to mirror the pattern of responses in version 1. The type of text used in the questions was not something this study controlled for, though it would be an interesting step for future research. The aim of this study was first to establish the effect of story type.

The differences in version showed us that though participants read the same material, their responses changed based on the question asked. Because the questions came from portions of text that included either more conversations or more exposition, the type of text may shed light into their responses. Somehow, participants pulled on their memory differently when the question about the text came from conversation or expository text. It is possible that the version difference and the balance of conversation to expository questions can be found in the attentional and memory literature. The superior performance in version 1 could be traced to a release from proactive inhibition. In classic release from proactive inhibition, subjects are given a list of items in one category then something from another category is inserted (Myers, 2001). The insertion of a new category increases memory for the list. Possibly changes in mode from conversations to expository text served as a release from inhibition in a similar manner. People were able to retain more because there were differences in what portions of the story questions came from. Conversations served to punctuate the narrative and gave structure to the story. One might imagine that reading only dialogue would be difficult to understand as some might experience when reading a play.

However, the evidence that there were differences between the true and false means was equivocal. A final response time analysis included both true and false response times as a within subjects variable, along with the other variables in the experiment. The results of this analysis, along with subsequent paired comparisons showed that the expected true-false difference holds up only for technical and story grammar in version 2. No evidence supports a distinction between true and false response times for speech act stories. Some evidence supports a version-specific distinction between true and false response times for the technical and story grammar types. While these results challenged the findings that there was a general advantage for the speech acts version for total response time, the ANOVA still reinforces the difference between the speech act story type, which shows no sensitivity to true-false from the other story types, which shows some sensitivity to this distinction.

Technical versus other story types. The technical story type was created to test another possible dimension of technical stories, namely the inclusion of technical information. The basis for comparing speech acts and story grammar to technical is based on the idea that those exposed to more information would retain more of that information. The technical story type was in effect a combination of the other two types as it had both conversations and exposition in the form of technical information. The response time data showed no difference between response times for technical and story grammar, or technical and speech acts. Technical was significantly worse than speech acts in proportion correct after that measure had been adjusted for reading level. The means for technical place it in between speech acts and story grammar tentatively suggesting that technical was only partially successful. The transfer literature would suggest that if the learning material and the testing material were similar, transfer would be easier (Morris, Bransford, & Franks 1977). The questions did not include conversations and most of the questions were directly relevant to fixing the car, therefore the transfer should have been easier in the technical version. The results do not show support for the influence of similarity in materials. This outcome was not consistent with the view that explicitness predicts performance, and lends further support to the superiority of the speech act story type.

Measuring Understanding of Stories

The qualitative questions should have captured differences in understanding between the different versions. However, there were no significant effects after removing effect of grade level. Unfortunately, the questions and the scoring of the responses were not sensitive to whatever learning might have occurred. As many in the various fields of psychology are aware, capturing measures of comprehension is an immensely difficult task. Apparently, the qualitative questions used in this study fell short in their goal to measure comprehension.

Another insignificant distinction was the separation of the questions into essential and less essential. One reason for the lack of finding is that the interpretation of what is essential or not essential is highly subjective. The a-priori distinction of what was essential or nonessential was based on how important the information was to the repair of a car. It is conceivable that information essential to car repair did not correlate with participants' concepts of what was essential. It is also possible that people do not systematically decide that some bits of the story are more important than others. It is likely that people end up remembering a combination of core elements of a story and peripheral elements. This is an interesting point when compared to post-modern literary theory (Bertens, 1993; Russell, 1993). Identifying essential and less essential parts of a story is a reflection of an objectivist's perspective, which would say that what is important to the writer of the story is what should be important to the reader. Clearly, this is not always the case. How text is interpreted cannot be fully understood by the creator of the text (Gergen, 1994).

Participating in the experimental conditions had an unintended effect in the measure of self-reported experience. When comparing self-reported experience across the four groups (1 control and 3 levels of story) the split-plot ANOVA was initially significant. Those who did not read stories reported less experience with cars then those who did. This result tells us that the presence of the story influenced how people perceived their own experience with car repair. However, this intriguing result was not significant after conducting a Dunnett test.

Summary

The results overall showed that speech acts produced faster and more accurate responses, a finding in line with speech act theory. Total and false response times as well as proportion correct support the distinction of speech acts from the story grammar and technical story types. The true response times were version specific and the qualitative measures were not sensitive to differences in story type. However, the general trend of the data showed that the inclusion of speech acts in the stories positively influenced participants' ability to answer questions about the story.

The importance of the elevation of speech act theory in story research is to point to alternative influences in stories. Stories are complex in nature and cognitive psychology's approach tends to abstract out content, meaning, and anything elusive or difficult to define (Bruner, 1990). Stories are not only effective because they have definable attributes that are countable. The content of the story influences how a reader approaches the story. The present research established conversation as a category of content. Speech act theory offers an alternative idea of how people approach stories. The holistic approach, which as discussed above advocates the importance of the whole of a story rather than its parts, is presenting a view in concert with speech act theory. Both suggest that readers approach a story differently based on what is in the story. Both suggest that stories cannot be completely defined by the categories or components they contain.

Future Research

The goal in this research was to reveal that story grammars may not be the only way to understand the effect of stories on memory. Speech act theory offers another point of view in how to classify stories. The evidence presented here suggested that there was indeed a difference between different types of stories that cannot be accounted for in the grammar literature. Beyond this initial finding, there are a myriad of questions that could be asked. The effect of the combination of conversation and text in stories is hinted at in the content analysis mentioned above. A manipulation of that balance would reveal the accuracy of those speculations. It might be interesting to compare a play to the speech act version of a story. The inhibition literature suggests that the speech act version would produce superior performance relative to a play as the former includes changes in modality.

Limitations

This study examined communicating technical information about car repair through stories. It is quite possible that stories told in other domains would result in different findings. The context in the story is no doubt important in how information is understood and remembered. Different contexts and different scenarios could alter the results found here. The results may not translate onto other areas where technical information is disseminated.

The qualitative questions used to assess subject's knowledge, though carefully thought out, might not have been an appropriate representation of the subject's understanding. An additional area that could have influenced results with the qualitative questions is the coding of those questions. The questions were coded on a 3 point scale, which may have obscured differences in the story types. This limitation points to the fundamental philosophical question of how to code comprehension.

The participants in this study consisted of only females. This was done with the hope to balance the gender influence of a typically male dominated content arena, namely car repair. However, affinity for conversation could be gender specific.

Contributions

The findings in this experiment show us that a story's grammar cannot account for all the variance associated with the ability to answer questions about a story. The presence of the conversations appears to affect response time and correctness in responding, which is not a result the story grammarians would predict. The pattern of effects interacts with story type, and cognitive theory should accommodate this result, either as a function of reading strategies or processing pathways.

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Appendix A – Pilot

Method

Participants

Thirty-six university students from a Midwestern university (24 female, 12 male) participated in the pilot study. Undergraduate students received course credit for their involvement. Participants had varying levels of self-reported expertise in dealing with car problems that were similar to those described in the stories.

Materials

Materials in this study consisted of different types of scenarios and stories. Three descriptions about different car repair situations were constructed (see Appendix K). Each of the scenarios has three versions, one for each story type. One version of each includes the components found in story grammars (SG) and as such had a protagonist, a predicament, a reaction by the protagonist, and a resolution to the situation. The next version tested the impact of speech acts (SA). These stories have more conversational interactions between characters in the story. The final version takes most of the text in the speech act stories, but substitutes technical step-by-step instructions for information given in conversation form (ST).

It is impossible to balance everything in the different types of stories and still maintain differences in one version over another. Flesch reading scores, grade levels, type of information, and word counts were adjusted to make the stories as comparable as possible and to uncorrelate the experimental conditions with these other features in all versions of the three stories where possible (see Tables 38-39). For example, while story grammar stories are always the shortest within a given scenario, other stories in other scenarios have comparably short lengths. This allows for adjustments in the dependent measure for significant correlations with word count. The stories were shown in paragraph form to balance the effect of visual scanning.

Table 38

Word Counts

	Overheated	Start Problem	Tail Light
Speech Acts	893	1103	441
Technical	866	1153	511
Story Grammar	414	534	329

Table 39

Reading Ease Scores and Grade Level for Stories

	Overheated		Start Problem		Tail Light	
	Reading	Grade	Reading	Grade	Reading	Grade
Speech Acts	84.4	4.2	85.2	4.2	86.6	3.9
Technical	81.6	4.8	81.4	4.8	89.1	3.7
Story Grammar	80.2	6.3	85.5	4.9	87.5	5.1

Higher scores on the Flesch reading ease scale means the text is easier to read.

Participants answered 30 true/false questions, 10 for each of the stories (see Table 40 for reading ease and grade scores and Appendix L for questions). Half of the questions were true and half were false. Scenarios were printed on white paper. Questions were delivered on a computer screen and responded to with key strokes.

Table 40

Reading Ease Scores and Grade Level for Questions Asked During Pilot

	True responses		False responses	
	Reading Ease	Grade	Reading Ease	Grade
Overheated Car	71.0	7.3	63.3	6.6
Start Car	91.2	3.3	84.4	4.4
Tail Light	85.4	4.1	93.0	3.2

Design

A 3x3 partially-confounded factorial design, as shown on page 535 of Kirk (1995). This allowed for the testing of both story type and scenario as within subjects effects, but hinders the testing of interactions. Some of the interactions are between subjects and some of the interactions are within subjects, and this confounding is swapped for one half of the data set. Order of story was counterbalanced using two different Latin Squares.

Procedure

Participants were run two at a time each sitting at their own computer desk. Each participant read one of the three versions of each of the stories. After they were done with the three scenarios, they set the stories aside. They then answered 30 true false questions on a Dell laptop. Instructions for the questions were displayed on the computer screen and were as follows: "Read and answer the following true/false questions about the stories you just read. Give the best answer based on knowledge you picked up from the stories." True answers were indicated by pressing *J*, and false answers were indicated by pressing *F*. The presentation of the questions was random within the block of 10, but each set of 10 reflected the order in which they read the stories. If the participant read about the overheated car first, they would answer all 10 questions about that scenario first.

Measures

The time participants take to respond to the questions was recorded as well as their accuracy in answering the questions.

Appendix B – Pilot Results

The amount of time in milliseconds participants took to answer questions was analyzed. Incorrect scores were dropped from the analysis (see Table 39 in Appendix D for number of correct responses).

Preliminary Analysis. After first adjusting for systematic subject effects, response time correlated with word count ($F(1, 106)$[3] $= 10.41$, $r = .30$, $p < .01$) and reading ease ($F(1, 106) = 4.44$, $r = .20$, $p < .05$). Scores further adjusted for word count did not correlate with reading ease ($F(1, 106) = .71$, $r = .08$, $p > .05$). Therefore, all scores were adjusted for word count only. Response time did not correlate with grade level ($F(1, 106) = 1.09$, $r = .10$, $p > .05$).

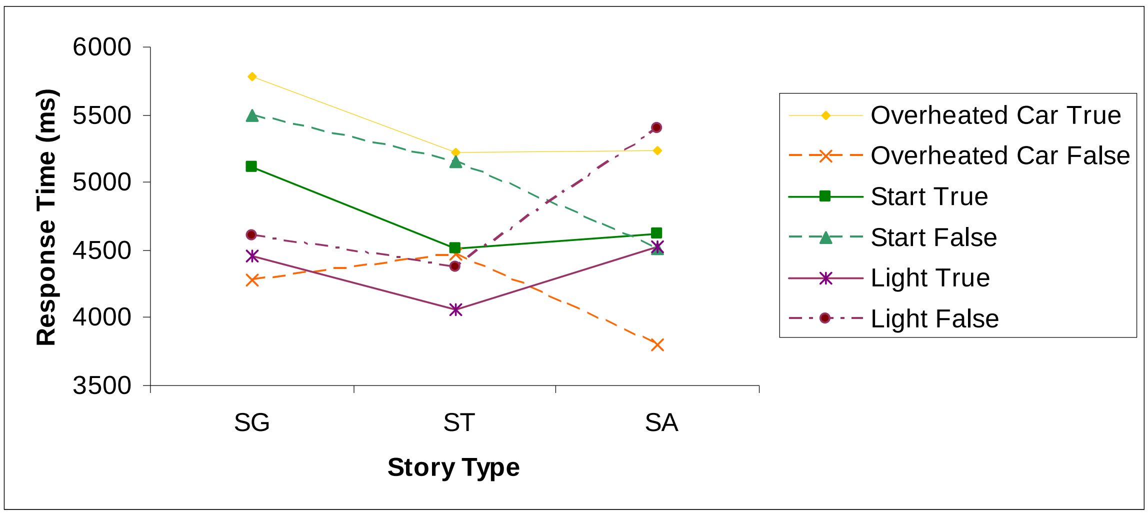
Effect of independent variables. The adjusted means can be seen in Figure 7, solid lines show true response times, dotted lines show false response times. These indicated an interaction between type of story and scenario for responses to both true and false items ($F(4, 64) = 602.08$, $p < .05$ and $F(4, 64) = 885.23$, $p < .05$). Post hoc contrasts were hindered by the design, as the interesting contrasts were between subjects comparisons. The omnibus F for these contrasts was not significant, but contrasts on such effects were not recommended in any case (Kirk, 1995). As can be seen in Figure 7 true responses for technical and speech acts look equivalent in the overheated car and start conditions and both appear to be easier than the story grammar stories. False responses for the same conditions (overheated and start) appeared to show that speech acts was easier than technical with technical being either easier or equivalent with the story grammar stories. The light scenario showed anomalous results. This scenario did

[3] I did not decrement the *dfs* by taking out subject effects, however the *F*s with 70 dfs would still be significant at $p < .05$.

not fit the pattern displayed by the other two scenarios. In this last scenario, the technical stories seemed to be easier than either the speech acts or story grammar stories.

Figure 7

True and False RT Adjusted for Word Count.



Note: Solid lines show true response times. Dotted lines show false response times.

Appendix C – Pilot Discussion

After adjusting response times for the word count in the stories, there was still a significant difference in response times for the different story types depending on scenario. This suggested that there was a difference between the story types that could not be accounted for with the readability of the stories. Although the question stimuli were quite simple, and potentially answerable without the story primes, we would not expect to find any effect of story type if responses relied on pre-existing memory. As we did find differences based on story type, the simplicity of the questions was not likely problematic.

However, respondents performed differently depending both on which story they read and what type of story they read. This suggested that there was something more to the ability to answer questions about a story than the type of story, and suggested the need for some modifications to the experimental stimuli.

Effects of Experimental Variables

Although the design complicates post-hoc testing, the pattern of results for false responses suggested that (at least in the Overheated car and Start conditions) speech acts was slightly easier than ST. In the true responses, speech acts appeared to be equivalent with technical for the same scenarios. In either case, the speech acts story appeared to be easier than the story grammar story, which was consistent with speech act theory. The Brake Light condition showed a different pattern of results suggesting that the technical stories were the easiest, consistent with cognitive theory. Though the directions of the results are not always consistent with the predictions based on story grammar research, speech act theory, or basic cognitive theory, the presence of any significant F suggested that there is more to a story than its components. The results indicated that the grammar of a story, held constant across the stimuli clearly does not account for all of the variance.

The potential pattern of differences across story type could not be due to differences in question because the same questions were used. Similarly, differences in familiarity of the questions were not a possible account for differences across type of story. However, *different questions were used across scenarios,* and different questions were used for false and true responses perhaps accounting for apparent interactions. Further, the easy, short “tail light” scenario appeared to behave differently than the other two stories. Perhaps these story confounds, such as word count, were not additive with comprehension processes, but rather interactive such that participants reduce comprehension effort on short, easy stories.

Expected Contributions

The preliminary findings showed us that a story’s grammar may not be able to account for all the variance associated with the ability to answer questions about a story. The presence of the conversations or the addition to the technical information appeared to affect response time, which was not a result the story grammarians would have predicted. The pattern of effects interacted with story type. This research has helped to establish story aspects that influence retention and understanding of story material beyond the constructs of story grammar theory. With such knowledge in hand, we might be able to maximize the benefits of stories in the conveyance of technical material.

Appendix D – Figures and Tables for Pilot Data

Figure 8

True Responses Unadjusted

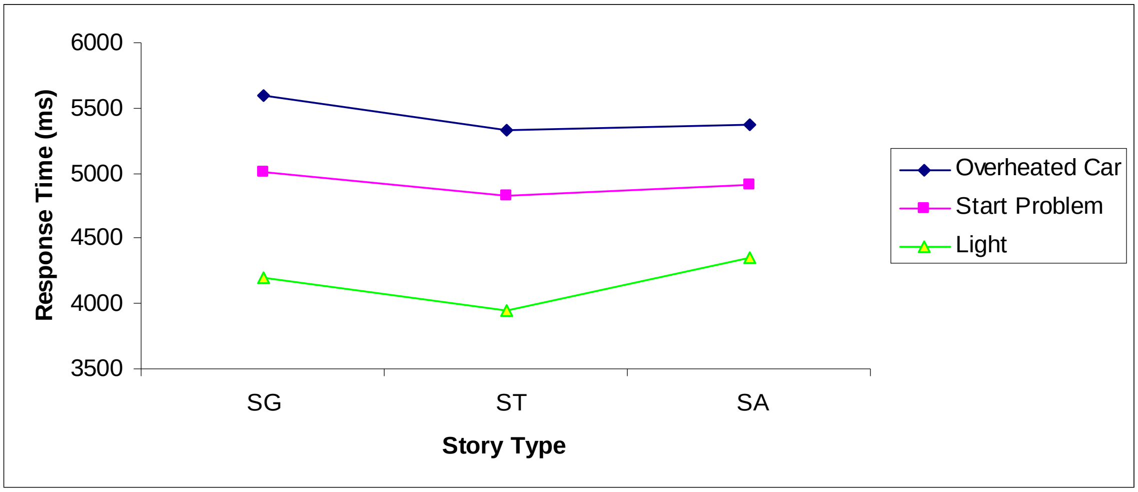


Figure 9

False Responses Unadjusted

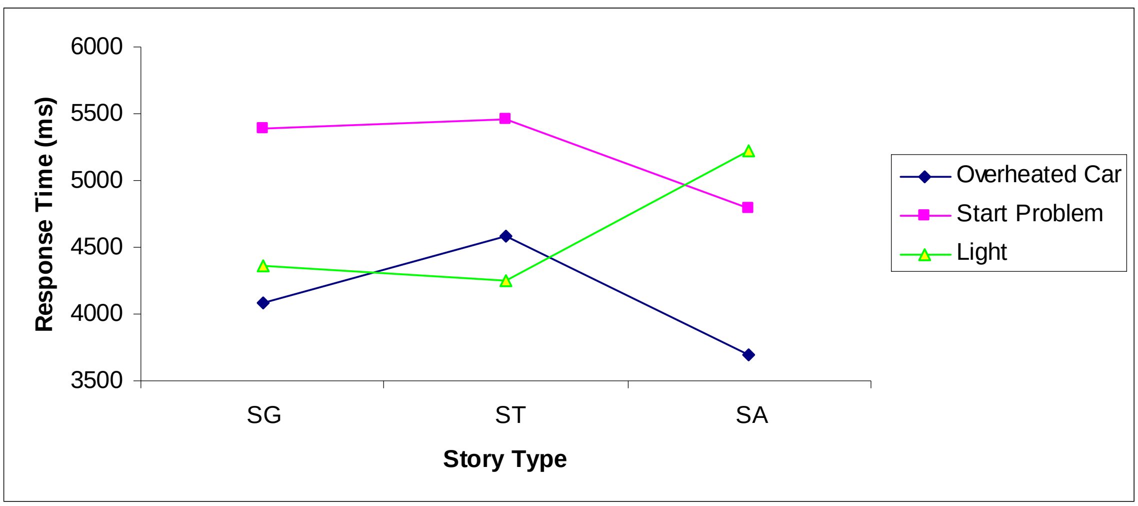


Table 41

Average Number of Items Answered Correctly in Pilot Data

	Number Correct		
	Story Grammar	Technical	Speech Acts
Overheated Car	8	8	9
Start Problem	9	8	8
Tail Light	9	9	8

Table 42

Pilot ANOVA for Word Count Adjusted for RTs: Responses to True Items

		Df	MS	F	Sig
Between	131930929.80	35			
Groups	450634.02	1	450634.0178		
Type*Scenarios (b/w)	9741241.42	4	2435310.356	0.600130427	
Subjects win					
Scenarios*Type'	121739054.40	30	4057968.479		
Within	94255282.19	72	1309101.141		
Type	7982536.07	2	3991268.034	31.25463091	*
Scenarios	18437421.97	2	9218710.985	72.18944125	*
Type*Scenarios (with)	59662418.35	4	14915604.59	116.8004033	*
Residual	8172905.80	64	127701.6531		
Total	226186212	107			

Note. * = p < .05

Table 43

Pilot ANOVA for Word Count Adjusted for RTs: Responses to False Items

		df	MS	F	Sig
Between	204536823.10	35			
Groups	3288713.41	1	90091660.98	90091660.98	
Type*Scenarios (bet)	28298426.04	4	1259481.411	1259481.411	
Subjects win					
Scenarios*Type'	172949683.70	30	90091660.98	90091660.98	
Within	110424058.20	72	1533667.474		
Type	1709865.07	2	854932.534	43.44302482	*
Scenarios	17363050.70	2	8681525.349	441.1479341	*
Type*Scenarios (with)	90091660.98	4	22522915.24	1144.492141	*
Residual	1259481.41	64	19679.39704		
Total	314960881.30	107			

Note. * = $p < .05$

Table 44

Reading Ease and Grade level of Pilot Questions

	True questions		False questions	
	Reading	Grade	Reading	Grade
Overheated Car	71.3	5.9	76.2	5.3
Start Problem	83.8	4.3	82.4	4.8
Tail Light	91.4	3.3	87.1	3.6

Table 45

Reading Ease, Grade level, and Word Count of Pilot Stories

	Overheated			Car Won't Start			Tail light		
	Reading	Grade	WC	Reading	Grade	WC	Reading	Grade	WC
Speech Acts	81.0	4.9	776	84.6	4.2	1103	89.5	3.4	408
Technical	80.4	5.0	939	80.4	4.8	1032	88.1	3.9	532
Story Grammar	71.4	7.5	760	80.8	5.7	955	87.4	4.8	409

Appendix E – Stories Used for Pilot

Car Won't Start Technical

"Good haul today" Carol chuckled as she and Amy struggled to exit the Bridgeford mall with their numerous packages.

"My husband's going to kill me." Amy grinned.

"Not before mine does me in."

When they reached Amy's dark blue Civic, Amy struggled to open the door without dropping any of the bags she held. It took some maneuvering, but she managed to get it open and the two women piled in the car.

They both sighed, glad finally to be able to relax their legs after a long day.

"Uh oh," said Amy.

Carol looked over at her friend. "What's wrong?"

Amy looked a bit scared and moved to turn the key. Nothing happened. No lights, no sound, absolutely nothing happened.

"The car won't start?" asked Carol.

"Do you have your cell on you?" asked Amy.

Carol sifted through her purse, but shook her head. "I think mine's at home."

Amy leaned over and pulled out the 'how to' book her husband had given her last Christmas. She read aloud.

How to troubleshoot a car that won't start

Step 1: Generally caused by either a dead battery or a bad starter, although you should check steps 1 through 5 to make sure it's not an operator error.

Step 2: Check for dead battery. Test wipers, radio, headlights, and heater fan. If all work normally, battery is probably charged and you may have bad starter. If they don't work, move on to next step.

Amy tried all the suggested actions, but nothing worked.

“I guess it’s time to go to the next step,” said Carol.

Step 3: Check connection at battery and at starter (see steps 8 and 9). If battery connections are good and all accessories work, consider jumpstarting car (see How to Start a Car with Jumper Cables).

“How do we do that?” asked Carol.

Amy got out of the car and ran her fingers through her hair.

Carol, joining her, scanned the parking lot. “Do you know how to open the hood?” she asked Amy.

Amy got back in the car and rooted around for a likely lever. After a few moments, they heard a pop and the hood sprang up a few inches.

Carol raised the hood the rest of the way.

“There’s some kind of metal pole that keeps the hood from falling.” said Amy. The two of them located said pole and propped the hood open.

Amy crossed her arms and stared at the engine as if waiting for it to tell her what was wrong.

Carol smiled at her friend’s determination, but wondered what they should do next. There was probably a pay phone inside somewhere, they could call one of their husbands to come pick them up. Or maybe they could ask a security guard. The mall probably had someone who could help them. While she was thinking of what to do, an older grandpa-like man walked by their car.

“Excuse me.” Carol called and waved at him.

“Car giving you troubles?” he asked good-naturedly.

“It won’t start.” answered Amy.

“Let me see if I can help.” he said. “Why don’t you get in and try to start it.” He listened when the key was turned, but the car made no noise.

“Hmm,” he grunted then came over to look under the hood. “I’d guess your battery’s dead.”

Carol looked at Amy, they both seemed to be wondering the same thing. ‘How serious was a dead battery, and could this man fix it?’

“My car’s just down in the next lane here. I’ll be back with some jumper cables.”

“Didn’t that book say something about how to start a car with jumper cables?” asked Carol.

A few minutes later, the elderly man drove up next to the car and pulled some thick wires out of his trunk. While he hooked the two cars up together, Amy and Carol read the section of the book about jumper cables.

How-To Steps

Step 1: Determine that a dead battery is the reason your car is not starting. If the engine cranks when you turn the key, the problem is not the battery and jump-starting won't help. If the windshield wipers, lights, and heater blower all work, the battery is probably fine and you may have a bad starter. A jump-start won't help if you have a bad starter. If you hear no sound at all when you turn the key or if the engine cranks very slowly and the accessories do not work, then you have a dead or low battery and it's time to break out the jumper cables.

Step 2: Find someone with a running car that can give yours a jump.

Step 3: Open the hoods on both cars and determine where the batteries are. Park the booster car (the one that's running) so that the batteries are adjacent.

Step 4: Turn off the booster car.

Step 5: Attach the red jumper cable's end to the positive terminal on the dead battery. Use a rag to wipe the battery clean if you can't see the Positive or plus (+) sign on the battery. The positive terminal is always slightly larger than the negative one.

Step 6: Attach the other end of the red cable to the booster battery's positive terminal.

Step 7: Attach the black jumper cable's end to the booster battery's negative terminal.

Step 8: Attach the other end of the black jumper cable to a ground on the dead car's engine; any solid metal part works fine. You may see a small spark when you attach the last end. This is normal.

Step 9: Turn on the booster car and rev the engine.

"Why don't you try starting it now." called the elderly gentleman from his seat in his car.

Amy gladly slipped into the car seat and turned the key, but it still didn't start.

He hopped out of his car and adjusted the clamps on both cars.

Carol leaned in through Amy's car window and continued reading.

Step 10: Turn on the dead car. If it doesn't start, you may have a poor connection at any of the four cable ends. Jiggle each cable end and try starting the car again.

Step 11: Once the car starts, disconnect the cables in reverse order of attachment: negative, negative, positive, positive.

Step 12: Keep the engine running on the jumped car for at least 20 minutes or longer so the alternator has sufficient time to recharge your battery.

When they had finished reading the book section Amy called over to the man helping them. “Should I try it again?”

“Yeah, go ahead”

Carol let out a whoop when the engine turned over and held.

“Thank you so much!” Amy called over the engine noise.

“Yes thank you!” echoed Carol.

The old man smiled his acceptance. While he unfastened the clamps, he cautioned them to keep the car running to allow the battery to recharge itself.

“Good haul today,” Carol chuckled as she and Amy struggled to exit the Bridgeford mall with their numerous packages.

“My husband’s going to kill me,” Amy grinned.

“Not before mine does me in.”

When they reached Amy’s dark blue Civic, Amy struggled to open the door without dropping any of the bags she held. It took some maneuvering, but she managed to get it open and the two women piled in the car.

They both sighed, glad finally to be able to relax their legs after a draining day.

“Uh oh,” said Amy.

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Amy looked a bit scared and moved to turn the key. Nothing happened, no lights, no sound, absolutely nothing happened.

“The car won’t start?” asked Carol.

“Do you have your cellphone on you?” asked Amy.

Carol sifted through her purse, but shook her head. “I think mine’s at home.”

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Carol, joining her, scanned the parking lot. “Do you know how to open the hood?” she asked Amy.

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Carol raised the hood the rest of the way.

“There’s some kind of metal pole that keeps the hood from falling,” said Amy. The two of them located said pole and propped the hood open.

Amy crossed her arms and stared at the engine as if waiting for it to tell her what was wrong.

Carol smiled at her friend’s determination, but wondered what they should do next. There was probably a pay phone inside somewhere; they could call one of their husbands to come pick them up, or maybe they could ask a security guard. The mall probably had someone who could help them. While she was thinking of what to do, an older grandpa-like man walked by their car.

“Excuse me,” Carol called and waved at him.

“Car giving you troubles?” he asked good-naturedly.

“It isn’t starting,” answered Amy.

“Let me see if I can help,” he said. “Why don’t you get in and try to start it.” He listened when the key was turned, but the car made no noise.

“Hmm,” he grunted then came over to examine the engine. “I’d imagine your battery’s dead.”

Carol looked at Amy, they both seemed to be wondering the same thing. ‘How serious was a dead battery, and could this man repair it?’

“My car’s just down in the next lane here. I’ll be back with some jumper cables.”

A few minutes later, the elderly man drove up next to the car and pulled some thick wires out of his trunk. “You two might want to think about getting yourselves a pair of these. That way if someone offers to help and they don’t have their own set, you can still get a jump start.”

“I’d be afraid I wouldn’t know how to use them.”

“Well then,” he smiled. “Would you like me to show you how?”

Both Carol and Amy nodded their heads. “Yes thank you.”

“First things first, we need to locate your battery. It’s this large square box, approximately 8x8x10. Do you see that?”

Again, both women nodded.

He guided them over to his car and asked them to locate the battery in his car too. “As long as the battery is a large box, I think I’ll be able to find it,” said Amy.

“Now we move onto these cables,” he held up the wires. “I’ve got two red handles and two black handles that attach to the battery. You’ll need to be careful because if you put them on in the wrong order, you could have a problem.”

“Which ones go first?” asked Carol.

“Red is my favorite color, that’s how I remember to always attach red first.” he grinned at them. “The red handle hooks onto the bolts near the red + sign on your car’s battery.”

He walked them back to her car, showed her the red plus sign, and then attached the clamp. “Then we go back over to my car and do the same thing.”

“The red handle clamps to the bolt near red + sign,” Amy recited.

“Next we work with the black handles but since we’re already here at my car, we’ll do my car first.”

“Does the black handle go on the bolt near the — sign?” asked Carol.

“Yep, you got it.” He handed the handle to Carol who attached this one to the bolt.

“For the final one, we’ll need to do something a little different.”

“It doesn't go near the — sign in my car?” asked Amy.

“No, it actually needs to be attached to any unpainted metal surface in your car.”

“Would this work?” Carol pointed to part of the engine frame.

“That’s perfect.” then he started to talk about why they clamped the handle to the metal and about electricity flowing through the last black handle, but Amy and Carol just looked at each other with raised eyebrows. He finished up with “I’ll do this last one because it can sometimes give a spark.”

The handle did indeed spark and both women jumped away from the car. “Don’t worry,” he continued. “It’s normal to have a little spark. You’ll only get a really big spark if you put the handles on wrong.”

“Now I’ll go rev the engine of my car to make the alternator put out more energy.”

About a minute later, he leaned out the window. “Why don’t you try starting it now?”

Amy gladly slipped into the car seat and turned the key, but it still didn’t start.

He hopped out of his car and adjusted the handles on both cars. “Sometimes you’ve got to adjust them to make sure they have a good connection.”

Another minute went by before Amy asked, “should I try it again?”

“Yeah, go ahead.”

Carol let out a whoop when the engine turned over and continued to run.

“Thank you so much!” Amy called over the engine noise.

“Yes thank you!” echoed Carol.

The old man smiled his acceptance, “Now who can guess how we get rid of these cables?”

Amy looked up at Carol who shrugged.

"We'll take them off in the opposite order that we put them on." While he unfastened the clamps, he cautioned the women to keep the car running for 20-30 minutes to allow the battery to recharge itself. "Otherwise, the car may not start again and you'll be in the same predicament you're in now."

Ann stuck her key in the ignition and turned it to start the car. She immediately noticed a lack of sound and light. The dash didn't light up, nor did her headlights turn on. The engine was oddly silent. Her first thought was to call someone for help. After fishing her cell out of her purse, she found that the battery was dead. She reached for the cell phone's car charger and plugged it in the cigarette lighter, but the charger's light didn't come on. Feeling a bit desperate she popped the hood and hoped someone would come help her.

After a while, an older man drove up to her car. He asked her if she needed help. Ann told him her car would not start. He moved his car in front of hers without touching the two cars, popped the hood, and got out his jumper cables. As he hooked up the two cars, he encouraged Ann to get a set of jumper cables for herself. Having your own set would increase the chance of getting a jump. He told her that if she did get these cables she should know how to use them. First, he pointed to a large box about 8x8x10 inches in size. He told her this was the battery. Then he held up the cables so she could see there were two sets of handles, two red and two black. He told her to hook one red handle up to the bolts near the positive end of the battery; first to her car, and the other red handle to the working car. When Ann looked a bit lost he pointed to the + sign on the battery. While still at his car, he clamped the black handle to the bolt next to the – sign. He picked up the last free handle, which was black, and told her that this should to be hooked to any solid piece of unpainted metal in her car, like part of the engine frame. The old man started to talk about current "flowing through" this last black handle. Ann just nodded to be polite. When he connected the last handle, a small spark flashed. Ann jumped back, but the old man told her that a small spark is normal.

Leaving Ann staring at the jumper cables, the old man turned on his car and revved the engine by pressing the gas. Ann asked why he was pressing on the gas. He started to talk about the alternator putting out more energy. Ann nodded and wished she had not asked. After about a minute, the man told Ann to try to start the car, but after turning the key for a few seconds, it did not start. The man reclamped the handles trying to get a better connection. After another minute or so, Ann tried the car again and it started. The man showed her how to remove the clamps by taking them off in the reverse order. Before he climbed back in his car to drive away, he cautioned her to keep the car running for at least 20-30 minutes to allow her battery to recharge itself. Otherwise, the car may not start again.

Jen couldn’t believe she was actually on the road on her way to see her sister’s new baby. Determined to have everything she needed for the trip, she had even stopped to fill up her gas tank the night before she left. She began the trip prepared and excited. What she had not prepared herself for was the needle on her dashboard’s temperature gauge moving into the red zone about halfway to her destination.

She felt like a responsible driver, and she had noticed the temperature gauge indicating the increasing temperature of her car. She responded to the heat warning just as her dad had taught her. She turned on the heater so the heat in the engine could be diverted into the cab of the car.

When the needle was deep into the red, she figured she needed to get it looked at. “Everyone I know lives hours away.” she thought in desperation as she pulled off the highway and into a nearby gas station. She flipped open her phone to call home, but her cell flashed ‘searching for service.’ With a groan of frustration, she tossed the phone on the seat and pulled open the ‘how to’ book on cars her dad had given her.

Step 1: Pull over as soon as it's safe to do so. Step 2: Open the hood, but realize that you mustn't open the hood if steam is coming out from your overheated car. You could get burned.

Jen didn’t see any steam coming out of the car. She took a quick glance down the rest of the instructions and wondered if there was anyone who could help her understand them. She opted to go inside the gas station.

The inside of the station looked clean and devoid of customers. A bored looking attendant stood near a rotating fan reading a newspaper.

“Excuse me?” she asked.

The attendant looked up.

“Do you know anything about cars?”

The young man looked up questioningly. “I know some things. What do you need?”

“My car just overheated.”

“Ah. That I do know something about. Did you check your coolant level?”

Jen just shrugged.

“Let me take a look.” he offered. “I just need to lock up the register.”

Jen beat him to the car so she started flipping through the ‘how to’ book again.

“Your car needs fluids to keep it cool.” the attendant began before he had even reached the car. “If your car doesn’t have fluids, it could be because of a leak. If it’s a little leak, it’s not much of a problem. You’ll just have to keep refilling what you’re losing”

“I think it might be a leak.” said Jen. “There have been spots of something showing up under the car for a while now.”

“We should check the coolant or antifreeze.”

Jen turned to the pages about how to check coolant and read along while he kept working.

Step 1: Find the coolant reservoir. Follow the hose that comes from the top of the radiator cap--it will lead to the coolant reservoir. It is usually a clear plastic tank with full and low indicators on the outside.

“Yeah. I’d say this is your problem. You need to get this filled up.”

Jen looked down into the plastic container straining to see anything remotely wet but it looked completely dry.

“I carry antifreeze in the station and there’s a water hose right next to your car. You’ll need to put in a mixture of the two of them.”

After purchasing the antifreeze Jen brought it out to the car. She turned on the water hose and got ready to pour the two fluids into the coolant tank.

She took another look in her book

Step 2: Open the cap and add coolant to the coolant reservoir. Coolant is a mixture of half antifreeze and half water. In a pinch it is ok to add only water or only antifreeze.

Step 3: Put the cap back on the coolant reservoir.

Step 4: Add coolant to the radiator if the reservoir was completely empty. Make sure the engine is completely cool before opening the radiator cap.

Step 5: If the car is still warm, turn the engine on while adding water and/or antifreeze.

The attendant came back out to help her so Jen handed the antifreeze and the hose to him and moved around to the drivers’ side to start the car.

“Go ahead.” he called.

She started the car and then moved back to the front of the car while he pointed the water hose and poured the antifreeze into the coolant overflow container.

When he was done he capped what was left of the antifreeze and handed it to her.

“You’ll want to keep an eye on the temperature to make sure it isn’t something else that was causing the problem.”

“Thank you so much.” said Jen. “You’re a lifesaver!”

“No problem.” he said then turned back to the store. “Be safe” he called over his shoulder.

Jen climbed back into the car. The temperature gauge was improving as she watched it. Oh, what a story she would have to tell her sister when she finally arrived.

Jen couldn’t believe she was actually on the road on her way to see her sister’s new baby. Determined to have everything she needed for the trip, she had even stopped to fill up her gas tank the night before she left. She began the trip prepared and excited. What she had not prepared herself for was the needle on her dashboard’s temperature gauge moving into the red zone about halfway to her destination.

She felt like a responsible driver, and she had noticed the temperature gauge indicating the increasing temperature of her car. She responded to the heat warning just as her dad had taught her. She turned on the heater so the heat in the engine could be diverted into the cab of the car.

When the needle was deep into the red, she figured she needed to get it looked at.

“Everyone I know lives hours away.” she thought in desperation as she pulled off the highway and into a nearby gas station. She flipped open her phone to call home, but her cell flashed ‘searching for service.’ With a groan of frustration, she tossed the phone on the seat and opted to go inside the gas station.

The inside of the station looked clean and devoid of customers. A bored looking attendant stood near a rotating fan reading a newspaper.

“Excuse me?” she asked.

The attendant looked up.

“Do you know anything about cars?”

The young man looked up questioningly. “I know some things. What do you need?”

“My car is overheating.”

"Ah. That I do know something about. Did you check your coolant level?"

Jen just shrugged.

"Let me take a look." he offered. "I just need to lock up the register."

Jen beat him to the car so she popped the hood.

"Your car needs fluids to keep it cool." he began before he had even reached the car. "If your car doesn't have fluids, it could be because of a leak. If it's a little leak, it's not much of a problem. You'll just have to keep refilling what you're losing"

"I think it might be a leak." said Jen. "There have been spots of something showing up under the car for a while now."

"We should check the coolant or antifreeze."

"How do you check the antifreeze?" Jen asked dutifully then leaned against the car feeling the summer sun beat on her neck. She wished she could get some coolant for herself.

He continued as if he still held a captive audience. "You can get it through the radiator cap, but you never ever want to open the radiator when a car is hot."

Jen perked up at his intensity. "Why not?"

"You see this?" he asked turning his arm over showing her a large patch of discolored skin. "This is a burn from a time I was stupid enough to mess with a hot radiator. "It's full of pressurized steam."

"How are you supposed to check the coolant then?"

"Look over here." he pointed to a large plastic tub marked coolant overflow. "This is where you would put the coolant." He twisted the cap off and looked inside. "You see where the line is that says hot? That's where the coolant should be when the car is hot."

“But I don’t see any liquid at all.”

“Yeah. I’d say this is your problem. You need to get this filled up.”

Jen looked down into the plastic container straining to see anything remotely wet but it looked completely dry.

“I carry antifreeze in the station and there’s a water hose right next to your car. You can get away with only adding one or the other, but it’s best to put in a mixture of the two of them.”

After purchasing the antifreeze Jen brought it out to the car. She turned on the water hose and got ready to pour the two fluids into the coolant tank.

“Don’t put it in just yet.” the attendant called to her.

Jen turned, surprised he hadn’t just gone back to his newspaper.

“You’ll want to start the car.”

“Why?” she asked. “Won’t it hurt the car if there’s not enough coolant?”

“It could.” he answered. “But you don’t want to put something cooler than your car” he pointed to the antifreeze “into the engine or it could crack the engine block. If your car is running it will circulate the new stuff in with the old so the temperature isn’t a shock to the engine.”

Jen handed the antifreeze and the hose to him and moved around to the drivers’ side to start the car.

“Go ahead.” he called.

She started the car and then moved back to the front of the car while he poured the antifreeze into the coolant overflow container.

When he was done he capped what was left of the antifreeze and handed it to her.

“You’ll want to keep an eye on the temperature to make sure it isn’t something else that was causing the problem.”

“Thank you so much.” said Jen. “You’re a lifesaver!”

“No problem.” he said then turned back to the store. “Be safe” he called over his shoulder.

Jen climbed back into the car. The temperature gauge was improving as she watched it.

Oh, what a story she would have to tell her sister when she finally arrived.

Jen's road trip took an unexpected turn when she saw the indicator on her heat gage was in the red. Her car was too hot. She thought if there was too much heat in the engine, she should move the heat into the car. Even though the day was scorching, she switched on her heater and turned the fan to high. She remembered how her friend had done quite a bit of damage to his car by not heeding the heat gage so moved to get the car off the road immediately. Luckily, she was right at an exit so she pulled off and into the first gas station available and turned off her car.

After coaxing the gas station clerk to offer aid, she watched him check the level of coolant in the car. Coolant is accessible from the radiator cap, but the clerk warned her never to open it. He had once tried to open a radiator when a car was too hot and still had the burn scars on his arm from the pressurized steam. He pointed to a large semi-clear plastic container labeled coolant overflow that stood empty. He said that usually this is filled with antifreeze and water. She asked him why there were marks on the container that said cold and hot. He said that those marks show how much liquid should be in there when the car is cold or when the car is hot. Jen could feel the heat from her car and looked at the level of water. It was lower than the mark for the hot car.

Jen bought some antifreeze from the gas station. He told her to start the car. When Jen raised her eyebrows, he explained that putting liquid in a warm engine could cause serious problems unless the car is running. The temperature difference between the antifreeze and the car could cause the engine block to crack. Though she wondered what an engine block was, she certainly didn't want it to crack. Using his hands as he talked, he indicated that when the car is running the antifreeze gets circulated with the rest of the coolant and doesn't shock the engine. After the coolant was added, the clerk closed her hood and she thanked him for his help. As he waved goodbye, he told her to keep an eye on the temperature gage. If there was a leak in her cooling system, she should get it fixed by a mechanic.

"You ever fixed a taillight before?" Alex asked from his spot leaning up against his friend Chris's car.

"How hard can it be?"

"Probably easier than paying off the ticket you got because it's out."

Chris threw him a disgruntled look before sitting in the driver's seat. "Tell me if the brake light comes on." he called.

"Only one light is coming on." answered Alex.

Chris got out of the car and walked back to Alex. "How am I supposed to get at it?" he asked.

Alex read aloud from the 'how to' book.

Step 1: Determine how the bulb is accessed: On some models the lens must be unscrewed from the outside, and on others the bulb is accessible only from inside the trunk. If there are no screws on the lens, you can assume that the bulb must be replaced from inside. Usually there will be a plastic cover that must be removed in order to access the bulb.

"You want me to clean out my trunk so I can change a lightbulb!?"

Alex continued to read: Step 2: Unscrew the lens on the outside, or take off the plastic cover from inside the trunk, to reveal the bulb.

Chris knelt down and peered around the taillight. "Hey," he called out. "I think I found something."

Alex got up from and walked toward the toolbox they had set on the driveway. "What do you need?"

“Looks like a Phillips head screwdriver will do it.”

Alex tossed him the required tool.

The plastic cover came off rather quickly, but when the bulb didn’t immediately follow, Alex looked back in the book

Step 3: To unscrew the bulb push in and turn at the same time. Step 4: Take the bulb with you to the auto supply store to help you find an exact duplicate.

After a grunt, Chris held a small bulb in his hand. “Got it. Now, can I have a lift?”

Alex rolled his eyes. “What would you do without me?”

At the auto parts store, Chris matched the burnt out bulb to the one he needed and they were soon back at Chris’ house.

Chris took a seat behind his car and tore into the new bulb’s container.

“Here,” Alex handed him a small wire brush and then read. Step 5: Clean the connection with a wire brush and/or wipe it clean with a rag if there's any corrosion.

After dutifully wiping the socket, he grabbed the new bulb. One side of the bulb had tiny bumps on it.

Alex continued to read. Step 6: Screw the new bulb into the empty socket Again, you'll have to push in and turn simultaneously. Line up the tiny raised bumps on the base of the bulb in order to screw it in.

Step 7: Test your work by stepping on the brakes while a friend watches the new bulb to make sure it lights up.

When Chris stepped on the break, Alex gave him the thumbs up sign.

“Now just put the thing back together and we’re done.”

"You ever fixed a taillight before?" Alex asked from his spot leaning up against his friend Christopher's car.

Christopher shrugged, "How difficult can it be?"

"Probably easier than paying off the ticket you received because it's out."

Christopher threw him a disgruntled look then slipped into the driver's seat. "Tell me if the brake light comes on," he hollered over his shoulder.

"Only one light is coming on," answered Alex.

Christopher got out of the car and walked back to Alex. "How am I supposed to get at it?" he asked.

"I don't know, maybe you access it inside the trunk?" offered Alex.

"You want me to clean out my trunk so I can change a lightbulb!"

"Maybe it's on the outside. See if there are screws around the plastic cover."

Christopher knelt down and peered around the taillight. "Hey," he called out, "I think I found something."

Alex got up and walked toward the toolbox they had placed on the driveway. "What do you need?"

"Looks like a Phillips head screwdriver will do it."

Alex tossed him the required tool.

The plastic cover came off rather quickly, but when the bulb didn't immediately follow, Alex leaned over to see what was holding him up. "What's up?"

"I can't get this thing out."

“You know you are supposed to push it in and turn it at the same time right?”

After a grunt, Christopher held a small lightbulb in his hand. “Got it. Now, can I have a lift?”

Alex rolled his eyes, “What would you do without me?”

At the auto parts store, they matched the burnt out lightbulb to the one they needed and were soon back at Christopher’s house.

Christopher took a seat behind his car and ripped open the new bulb’s container.

“Here,” Alex handed him a small wire brush. “You’ll need to make sure there’s no corrosion before you put the new one in.”

After dutifully wiping the socket, he grabbed the new lightbulb. Christopher looked at the bulb for a moment, then he held it up for Alex to see. “Do you know why one side of the lightbulb has tiny bumps on it?”

“You can actually put these things in backwards and to get them in right, you have to line up the bumps with the ones in the socket.”

Christopher held the bulb up to the light socket, “Like that?”

“Yep, you got it. Now why don’t you go step on the brake so we can make sure it’s working.”

When Christopher stepped on the break, Alex gave him the thumbs up sign.

“Now just put the thing back together and we’re done.”

Ben looked up from his newly received fix-it ticket to his car's malfunctioning taillight. His friend sat in the driver's seat and Ben signaled to him to press on the brake. He watched where the brake light was supposed to flash, but no light turned on. He hoped it was just a burned out bulb. He kneeled down looking for the screws that held the plastic covering over the light in place. He knew the white or red plastic cover of some cars were accessible from the outside and some from inside the trunk. He had no desire to clean out his trunk. Happily, he found them on the outside and began unscrewing.

Once he removed the cover, Ben reached in to unscrew the newly exposed bulb. His friend called out that the bulb would have to be pushed in and turned at the same time for it to be removed. With the bulb in hand, Ben and his friend drove to the auto parts store to find the exact duplicate. When they came back to the car, Ben grabbed a wire brush to clean any corrosion that might have accumulated in the light socket The socket was clean so he screwed the new bulb in having to push and turn at the same time.

He saw tiny raised bumps at the base of the bulb and asked his friend about them. His friend told him to line up the bumps on the base of the bulb with the light socket so he didn't end up screwing the bulb in the wrong way. Ben was surprised a bulb would go in backwards and his friend said the way to tell is if the light is not as bright as before, or it won't work at all. Finally, Ben replaced the plastic cover and secured in the screws. His friend climbed in the car and tested the brake. Ben gave him the thumbs-up sign. The brake light was working properly.

Appendix F – Questions Used for Pilot

	Overheated Car	TRUE/FALSE
1	When a car is overheated you should put liquid in the car at the same time you try to start it.	TRUE
2	A leak can cause your car to overheat.	TRUE
3	Adding something to the engine that is a different temperature than the engine could hurt the car.	TRUE
4	If the temperature of the car doesn't improve after adding coolant, there is something else wrong with the car.	TRUE
5	After adding antifreeze, you hope to see the temperature gauge moving out of the red.	TRUE
6	Your car does not need coolant to run effectively.	FALSE
7	The needle moving into the green indicates the car is overheating.	FALSE
8	Opening the radiator is safe if the car is hot.	FALSE
9	The coolant container is in the trunk.	FALSE
10	It's difficult to locate the coolant container.	FALSE

	Car won't start	
1	The jumper cables have clamps.	TRUE
2	The first red clamp is attached to the dead car's battery.	TRUE
3	You should get in the car to start the car.	TRUE
4	After jumping a car, you should close the hood of the car.	TRUE
5	If the car doesn't start after the jumper cables are connected, you may have to adjust the clamps.	TRUE
6	It is reasonable to assume that everyone has his or her own jumper cables.	FALSE
7	You have to have your own jumper cables to get your car jumped.	FALSE
8	The battery cannot be seen when the hood is up.	FALSE
9	The spark comes from attaching the last clamp to the dead battery.	FALSE
10	Cell phones are not helpful when your car won't start.	FALSE

	Brake Light	
1	You may need to use a screwdriver to remove the light cover.	TRUE
2	A wire brush can be used to remove corrosion.	TRUE
3	Stepping on the brake will indicate whether the new bulb is working.	TRUE
4	You can access the taillight from the trunk.	TRUE
5	The bumps on the light bulb are a guide to putting the light bulb in correctly.	TRUE
6	You can access the taillight from the front of the car.	FALSE
7	Corrosion is not a problem in light sockets.	FALSE
8	Fixing a burned out tail light is best done alone.	FALSE
9	A car's light bulb can only be put in one way.	FALSE
10	It is not a good idea to use the old bulb as a reference to find the new bulb.	FALSE

Appendix G – Demographics for Survey Used in the Pilot

Disclaimer – different cars have different
configurations and you should consult your manual
before attempting to fix your car.

Circle your response to the following questions:

How much experience have you had changing a brake light prior to this experiment?

Lots – Some – Average – Little – None

How much experience have you had with an overheated car prior to this experiment?

Lots – Some – Average – Little – None

How much experience have you had with a car that won't start prior to this experiment?

Lots – Some – Average – Little – None

How much mechanical experience do you have with cars?

Lots – Some – Average – Little – None

Gender ___

Appendix H – Story Stimuli for Experiment

Car won’t start Story Grammar

Amy struggled to exit the Bridgeford mall with her many packages. Pleased with her haul, she still wondered about her husband’s response to all the money she had spent. When she got to her dark blue Civic, Amy tried to open the door while not dropping any of the bags she held. It took some effort, but she got it open and she sat down in the car. She sighed, glad finally to be able to sit after a long day. Amy stuck her key in the ignition and turned it to start the car. The car did not start. Amy frowned and turned the key again. Nothing happened, no lights, no sound, absolutely nothing happened. The dash did not light up, nor did her headlights turn on. The engine was oddly silent. She thought the starter might be bad. Her first thought was to call someone for help. After fishing her cell out of her purse, she realized her cell was dead. She reached for the cell phone's car charger and put it in the cigarette lighter, but the charger’s light did not come on. Feeling unsure, she got out of the car and scanned the parking lot for help. She hoped someone would help her soon. She was not sure of how to open the hood. She got back in the car and rooted around for a likely lever. After a few moments, she heard a pop and the hood sprang up a few inches. She got out of the car to raise the hood the rest of the way. She finally found the metal pole that kept the hood from falling. Amy propped the hood open, crossed her arms, and stared at the engine as if it would tell her what was wrong.

While she thought of what to do, an older grandpa-like man walked by her car. Amy called out and waved to catch his eye. He smiled and asked her if she needed help. Amy told him her car would not start and he offered to help. She tried to start the car again. He listened when the key was turned, but the car made no noise. Peering over the engine, he suggested the battery might be dead. Amy wondered about how serious this might be and if this man could fix it. The man left to get his own car. A few minutes later, he drove up next to Amy's car, turned off his own car, and pulled some thick wires from his trunk. As he hooked up the two cars, he encouraged Amy to get her own set of jumper cables. Having a set of her own would increase the chance of getting a jump. He told her that if she did get these cables she should learn how to use them. He pointed to a large box about 8 x 8 x 10 inches in size. He told her this was the battery, and pointed to the battery in his car too. Amy figured she could find a battery on her own as long as it looked liked a large box. Then he held up the cables so she could see there were two sets of handles, two red and two black. He told her to hook these up in order, to avoid problems. When Amy looked at him questioningly, he said that he remembers to attach the red one first because red is his favorite color. The red handle hooks up to the bolt near the positive end of the battery; first to her car, and the other red handle to the working car. While still at his car, he told Amy to clamp the black handle to the bolt next to the "–" sign. Amy attached the handle to the bolt near the "–" sign while the man nodded in approval. He picked up the last free handle, which was black, and told Amy that this should to be attached a little differently, to any solid piece of unpainted metal in her car, like part of the engine frame. Then he talked about why they clamped the handle to the metal and about electricity flowing through the last black handle. He said the last handle will often cause a small spark no matter where you attach it and you do not want that spark to be near the battery. If you attach it to the battery, the battery could explode. Amy's eyes got wide. She did not want her car to explode. The man offered to do the last handle and when he connected the last handle, a small spark did flash. Amy jumped back, but the old man told her that a small spark is normal, but a really big spark only happens if you put the handles on wrong.

While Amy stared at the jumper cables, the old man turned on his car and revved the engine by pressing the gas. Amy asked why he was pressing on the gas. He said it helps the alternator putting out more energy. Amy nodded and wished she had not asked. After about a minute, the elderly man leaned out the window and told Amy to try to start the car. Amy gladly slid into the car seat and turned the key, but it still did not start. The man hopped out of his car and adjusted the handles on both cars to get a better connection. Another minute went by before Amy tried the car again. She let out a whoop when the engine turned over and held. Amy was very grateful. The old man nodded in recognition. Then he showed her how to remove the handles by taking them off in the reverse order of attachment. While he unhooked the handles, he cautioned Amy to keep the car running for 20 - 30 minutes to allow the battery to recharge itself. Otherwise, the car may not start and she would find herself stranded again. And with that warning the old man smiled and waved good bye.

"Good haul today," Carol chuckled as she and Amy struggled to exit the Bridgeford mall with their numerous packages.

"My husband's going to kill me," Amy grinned.

"Not before mine does me in."

When they reached Amy's dark blue Civic, Amy struggled to open the door without dropping any of the bags she held. It took some maneuvering, but she managed to get it open and the two women piled in the car. They both sighed, glad finally to be able to relax their legs after a tiring day.

"Uh oh," said Amy.

Carol looked over at her friend, "What's wrong?"

Amy frowned and moved to turn the key again. Nothing happened, no lights, no sound, absolutely nothing happened. The dash didn't light up, nor did her headlights turn on.

"The car won't start?" asked Carol. "Maybe your starter went bad?"

"Do you have your cellphone on you?" asked Amy.

Carol fished through her purse, and pursed her lips. "I think I need to charge it."

Luckily, Carol carried her charger with her. She plugged it into the cigarette lighter, but the charger's light didn't come on.

Feeling rather desperate, Amy got out of the car. Carol, joining her, scanned the parking lot for help. They hoped someone would rescue them soon.

“Do you know how to open the hood?” Carol asked Amy. Amy got back in the car and rooted around for a likely lever. After a few moments, they heard a pop and the hood sprang up a few inches. Carol raised the hood the rest of the way.

“There’s some kind of metal pole that keeps the hood from falling,” said Amy.

The two of them located said pole and propped the hood open. Amy crossed her arms and stared at the engine. While she was thinking of what to do, an older grandpa-like man walked by their car.

“Excuse me,” Carol called and waved at him.

“Car giving you troubles?” he asked good-naturedly.

“It isn’t starting,” answered Amy.

“Let me see if I can help,” he said. “Why don’t you get in and try to start it.” He listened when the key was turned, but the car made no noise. “Hmm,” he grunted then came over to examine the engine. “I’d imagine your battery’s dead.”

Carol looked at Amy, they both seemed to be wondering the same thing. ‘How serious was a dead battery, and could this man repair it?’

“My car’s just down in the next lane here. I’ll be back with some jumper cables.” A few minutes later, the elderly man drove up next to Amy’s car, turned off his own car, and pulled some thick wires out of his trunk. “You two might entertain the idea of getting yourselves a set of these. That way if someone offers to help and they don’t have their own set, you can still get a jump start.”

“I’d be afraid I wouldn’t know how to use them.”

“Would you like me to show you how?” he smiled.

Both Carol and Amy nodded their heads. “Yes, thank you.”

“First things first, we need to locate your battery. It’s this large square box, approximately 8x8x10. Do you see that?” Again, both women nodded.

“As long as the battery is a large box, I think I’ll be able to find it,” said Amy.

“Now let’s look at these cables,” he held up the wires. “I’ve got two red handles and two black handles that attach to the battery. You’ll need to be careful because if you put them on in the wrong order, you could have a problem.

“Which ones go first?” asked Carol.

“Red is my favorite color, that’s how I remember to always attach red first.”

“The red handle hooks onto the bolts near the red “+” sign on your car’s battery. Then we go back over to my car and do the same thing. Next we work with the black handles but since we’re already here at my car, we’ll do my car first.”

“Does the black handle go on the bolt near the “—” sign?” asked Carol.

“Yep, you got it.” He handed the handle to Carol who attached this one to the bolt. “For the final one, we’ll need to do something a little different.

“It doesn't go near the “—” sign in my car?” asked Amy.

“No, it actually needs to be attached to any unpainted metal surface in your car.”

“Would this work?” Carol pointed to part of the engine frame.

“That’s perfect.”

Then he started to talk about why they clamped the handle to the metal and about electricity flowing through the last black handle. “The last handle that is attached will usually cause a little spark no matter where you attach it. You just don’t want that spark to be near the battery. If you attach it to the battery, the battery could explode.

Amy and Carol looked at each other with wide eyes. Was the car about to explode?

He finished up with, “I’ll do this last one.” The handle did indeed spark and both women jumped away from the car. “It’s ok,” he continued. “Remember, a little spark is normal. You’ll only get a really large spark if you put the handles on wrong.” While Amy and Carol stared at the jumper cables the old man told them “Now I’ll go rev the engine of my car to make the alternator put out more energy.” Amy and Carol shrugged their shoulders at this technical explanation. About a minute later, the elderly gentleman leaned out the window and called to the women “Why don’t you try starting it now?” Amy gladly slid into the car seat and turned the key, but it still didn’t start. The man hopped out of his car and adjusted the handles on both batteries. “Sometimes you’ve got to adjust them to make sure they have a good connection.”

Another minute went by before Amy asked, “should I try starting it again?”

“Yeah, go ahead.”

Amy let out a whoop when the engine turned over and held.

“Thank you so much!” Amy called over the engine noise.

“Yes thank you!” echoed Carol.

The old man nodded in recognition.

“Now who can guess how we get rid of these cables?”

Amy and Carol waited for him to continue.

“We’ll take them off in the opposite order that we put them on.” While he unfastened the handles, he cautioned the women to keep the car running for 20-30 minutes to allow the battery to recharge itself. “Otherwise, the car may not start and you’ll find yourselves stranded again.” And with that warning the old man smiled and waved good bye.

“Good haul today” Carol chuckled as she and Amy struggled to exit the Bridgeford mall with their numerous packages.

“My husband’s going to kill me.” Amy grinned.

“Not before mine does me in.”

When they reached Amy’s dark blue Civic, Amy struggled to open the door without dropping any of the bags she carried.

It took some maneuvering, but she managed to get it open and the two women piled in the car. They both sighed, happy finally to be able to relax their legs after a long day.

“Uh oh,” said Amy.

Carol looked over at her friend. “What’s wrong?”

Amy frowned and moved to turn the key again. Nothing happened, no lights, no sound, absolutely nothing happened. The dashboard didn’t light up, nor did her headlights turn on.

“The car won’t start?” asked Carol.

Feeling a bit desperate, Amy leaned over and pulled out the ‘how to’ manual her husband had given her last Christmas. She read aloud.

How to troubleshoot a car that won’t start. Step 1: Generally caused by either a dead battery or a bad starter, although you should check steps 1 through 5 to make sure it's not an operator error.

Step 2: Check for dead battery. Test wipers, radio, headlights, and heater fan. If all work normally, battery is probably charged and you may have bad starter. If they don't work, move on to next step.

Amy tried all the suggested actions and nothing worked.

“I guess it’s time to go to the next step,” said Carol. Step 3: Consider jumpstarting car (see How to Start a Car with Jumper Cables). Open the hood.

“Do you know how to open the hood?” Carol asked Amy. Amy got back in the car and rooted around for a likely lever.

After a few moments, they heard a pop and the hood sprang up a few inches. Carol raised the hood the rest of the way.

“There’s some kind of metal pole that keeps the hood from falling,” said Amy.

The two of them located said pole and propped the hood open. Amy crossed her arms and stared at the engine as if waiting for it to tell her what was wrong. While she was thinking of what to do, an older grandpa-like man walked by their car.

“Excuse me.” Carol called and waved at him.

“Car giving you troubles?” he inquired good-naturedly.

“It isn’t starting,” answered Amy. “Let me see if I can help,” he said.

“Why don’t you get in and try to start it.” He listened when the key was turned, but the car made no noise.

“Hmm,” he grunted then came over to examine the engine. “I’d imagine your battery’s dead.”

Carol looked at Amy, they both seemed to be wondering the same thing. ‘How serious was a dead battery, and could this man repair it?’

“My car’s just down in the next lane here. I’ll be back with some jumper cables. You two might want to think about getting yourselves a set of these. That way if someone offers to help and they don’t have their own set, you can still get a jump start.”

“Didn’t that manual say something about how to start a car with jumper cables?” asked Carol.

How-To Steps

Step 1: Find someone with a running car that can give yours a jump.

Step 2: Park the booster car (the one that's running) so that the batteries are adjacent.

Step 3: Turn off the booster car.

A few minutes later, the elderly man drove up next to the car and pulled some thick wires out of his trunk. While he hooked the two cars up together, Amy and Carol continued to read the section of the manual about jumper cables.

Step 4: Open the hoods on both cars and determine where the batteries are. Look for a large square box, approximately 8x8x10.

Step 5: Attach the cables in the right order to avoid problems. Attach the red jumper cable first. Put one handle on the positive terminal on the dead battery.

Step 6: Attach the other handle of the red cable to the booster battery's positive terminal.

Step 7: Attach the black jumper cable's handle to the booster battery's negative terminal bolt, next to the “—” sign.

Step 8: Finally, attach the other handle of the black jumper cable a little differently. It goes to a ground on the dead car's engine; any unpainted metal surface such as the engine frame is appropriate. Attaching the handle to the metal surface allows electricity to flow. You may see a small spark when you attach the last end. This is normal. A large spark may occur if you attach the last handle to the battery. A large spark is dangerous and could result in your battery exploding.

Step 9: Turn on the booster car and rev the engine to make the alternator put out more energy.

About a minute later, the elderly gentleman leaned out the window and called out “Why don’t you try starting it now?”

Amy gladly slid into the car seat and turned the key, but it still didn’t start. The man hopped out of his car and adjusted the handles on both cars to get a better connection. Carol leaned in through Amy’s car window and continued reading.

Step 10: Turn on the dead car. If it doesn't start, you may have a poor connection at any of the four cable ends. Jiggle each cable end and try starting the car again.

Amy called over to the man helping them. “Should I try it again?”

“Yeah, go ahead.”

Carol let out a whoop when the engine turned over and held.

“Thank you so much!” Amy called over the engine noise.

“Yes thank you!” echoed Carol.

The old man nodded in recognition. “Now what does the manual say?” asked Carol.

Step 11: Once the car starts, disconnect the cables in reverse order of attachment: negative, negative, positive, positive.

Step 12: Keep the engine running on the jumped car for at least 20 minutes or longer so the alternator has sufficient time to recharge your battery.

While he unfastened the handles, he cautioned them to keep the car running. “Otherwise, the car may not start and you’ll find yourselves stranded again.” And with that warning the old man smiled and waved good bye.

Jen could not believe she was actually on the road on her way to see her sister's new baby. Determined to have everything she needed for the trip, she had even stopped to fill up her gas tank the night before she left. She began the trip prepared and excited. What she had not prepared herself for was the needle on her dashboard's temperature gauge moving into the red zone about halfway to her destination. She felt like a responsible driver, and she had noticed the temperature gauge showing the rising temperature of her car. She responded to the heat warning just as her dad had taught her. She turned on the heater so the heat in the engine could be moved into the cab of the car. When the needle was deep into the red, she figured she needed to get it looked at. Not close enough to reach any of her friends, she took the next exit off the highway and turned into the nearest gas station. She flipped open her phone to call home, but her cell flashed 'searching for service.' With a groan of frustration, she tossed the phone on the seat and headed inside to talk to the gas station clerk.

A bored looking clerk stood near a rotating fan reading a newspaper. Jen politely interrupted him, and he looked up. Assuming that the clerk knew enough about cars to handle her problem, Jen asked what she should do for an overheated car. The clerk offered to check the coolant in the radiator, but the clerk warned her never to open the radiator cap when the car is hot. He had once tried to mess with a hot radiator and showed her the large scars on his arm from the pressurized steam. He locked up the register and headed to the car. Jen tagged along so that she could watch, wondering whether a clerk with burns would know what he was doing. On their way to the car, the clerk explained that cars need fluid to stay cool. Leaks can sometimes cause the radiator to loose coolant. He reassured Jen that little leaks are not a big problem because she could just keep refilling what was lost. Jen remembered spots of liquid showing up under her car lately.

The clerk pointed to a large semi-clear plastic container labeled "coolant overflow" that stood empty. He said that usually this is filled with antifreeze and water. He pointed to the marks on the container. One mark showed how much liquid should be in there when the car is cold. Another mark showed how much liquid should be in the container when the car is hot. Jen looked down into the plastic container straining to see anything remotely wet but it looked completely dry. Clearly, this was a problem. Jen bought some antifreeze from the gas station and the clerk twisted off the cap on the coolant overflow container. The clerk pointed to the water hose and suggested she add a mixture of water and antifreeze. He pointed out that one or the other would do in a pinch. Jen turned on the water hose and prepared to pour the two fluids into the coolant tank when the clerk stopped her. He told her the car needed to be started at the same time the liquids were being poured in. Jen thought about the safety of her car without coolant. But the clerk said that putting liquid in a warm engine could cause serious problems unless the car is running. The temperature difference between the antifreeze and the car could cause the engine block to crack. Though she wondered what an engine block was, she knew she did not want it to crack. Gesturing with his hands, the clerk indicated that when the car is running the antifreeze is circulated with the rest of the coolant. When it is circulated, the temperature of the liquid does not shock the engine. Jen handed the antifreeze and the hose to him and moved around to the drivers' side to start the car. She started the car and then moved back to the front of the car while he poured the antifreeze into the coolant overflow container.

When he was done, he capped what was left of the antifreeze and handed it to her. As he said goodbye, he told her to keep an eye on the temperature gauge. If there was a leak in her cooling system, she should get it fixed by a mechanic. Jen thanked the mechanic and he wished her a safe trip. Jen climbed back into the car. The temperature gauge was improving as she watched it. She would have quite a story to tell her sister when she finally arrived.

Jen couldn't believe she was actually on the road on her way to see her sister's new baby. Determined to have everything she needed for the trip, she had even stopped to fill up her gas tank the night before she left. She began the trip prepared and excited. What she had not prepared herself for was the needle on her dashboard's temperature gauge moving into the red zone about halfway to her destination. She felt like a responsible driver, and she had noticed the temperature gauge indicating the increasing temperature of her car. She responded to the heat warning just as her dad had taught her. She turned on the heater so the heat in the engine could be diverted into the cab of the car. When the needle was deep into the red, she figured she needed to get it looked at. "Everyone I know lives hours away" she sighed as she pulled off the highway and into a nearby gas station. She flipped open her phone to call home, but her cell flashed 'searching for service.' With a groan of frustration, she tossed the phone on the seat and headed for the gas station attendant.

A bored looking attendant stood near a rotating fan reading a newspaper.

"Excuse me?" she asked. The attendant looked up. "Do you know anything about cars?"

The young man looked up questioningly, "I know some things, what do you need?"

"My car is overheating" said Jen.

"That I do know something about. Did you check your coolant level?"

Jen just shrugged.

"We can take a look right now. Just one second, I need to lock up the register."

Jen tagged along so that she could watch, wondering whether an attendant with burns knew what he was doing. On their way to the car, the attendant explained, "Your car needs fluids to keep it cool. Sometimes a leak in your radiator causes it to loose coolant. "If it's a little leak, it's not much of a problem. You'll just have to keep refilling what you're losing."

"I think it might be a leak," said Jen. "There have been spots of some liquid showing up under the car for a while now."

Jen popped the hood, feeling the heat from the engine. She wouldn't mind a little coolant herself.

The attendant pointed to a large semi-clear plastic container labeled "coolant overflow" that stood empty. He said that usually this is filled with antifreeze and water. "You see where the line is that says hot? That's where the coolant should be when the car is hot." Jen looked down into the plastic container straining to see anything remotely wet but it looked completely dry. "This is your problem," said the attendant. Jen bought some antifreeze from the gas station and the attendant twisted off the cap on the coolant overflow container.

"There's a water hose right next to your car. You can get away with only adding antifreeze, but you can put in a mixture of the two of them" said the attendant. "One or the other would do in a pinch."

Jen turned on the water hose and prepared to pour the two fluids into the coolant tank.

"Don't put it in just yet," the attendant cautioned. "You'll want to start the car while we pour in the liquids."

"Why?" she asked. "Won't it hurt the car if there's not enough coolant?"

“It could,” he answered, but you don’t want to put something cooler than your car” he pointed to the antifreeze “into the engine or it could crack the engine block.”

Though she wondered what an engine block was, she certainly didn’t want it to crack.

“If your car is running it will circulate the new stuff in with the old so the temperature isn’t a shock to the engine,” the attendant explained.

Jen handed the antifreeze and the hose to him and moved around to the drivers’ side to start the car. She started the car and then moved back to the front of the car while he poured the antifreeze into the coolant overflow container.

When he was done, he capped what was left of the antifreeze and handed it to her.

“You’ll want to keep an eye on the temperature to make sure there isn’t a leak in your cooling system because that will need to be fixed by a mechanic.”

“Thank you so much,” said Jen. “You’re a lifesaver!”

“Be safe” he called over his shoulder.

Jen climbed back into the car. The temperature gauge was improving as she watched it. She would have quite a story to tell her sister when she finally arrived.

Jen couldn't believe she was actually on the road on her way to see her sister's new baby. Determined to have everything she needed for the trip, she had even stopped to fill up her gas tank the night before she left. She began the trip prepared and excited. What she had not prepared herself for was the needle on her dashboard's temperature gauge moving into the red zone about halfway to her destination. She felt like a responsible driver, and she had noticed the temperature gauge indicating the increasing temperature of her car. She responded to the heat warning just as her dad had taught her. She turned on the heater so the heat in the engine could be diverted into the cab of the car. When the needle was deep into the red, she figured she needed to get it looked at. "Everyone I know lives hours away" she sighed as she pulled off the highway and into a nearby gas station. She flipped open her phone to call home, but her cell flashed 'searching for service.' With a groan of frustration, she tossed the phone on the seat and pulled open the 'how to' manual on cars her dad had given her and looked up the section on cars that are overheating.

Step 1: Pull over as soon as it is safe.

Step 2: Open the hood, unless steam is coming out from your car. Beware! You could get burned.

After reading this, she headed inside the gas station. A board looking attendant stood reading a newspaper.

"Excuse me?" she asked. "Do you know anything about cars?"

The young man looked up questioningly. "What do you need?"

“My car is overheating,” said Jen.

“Did you check your coolant level?”

Jen just shrugged.

“I learned the hard way how to deal with an overheated car. You see this?” he asked, turning his arm over to show her a large patch of discolored skin. “This is a burn from a time I was stupid enough do mess with a hot radiator full of pressurized steam. We can look right now. I’ll be out as soon as I lock up the register.”

Jen tagged along so that she could watch, wondering whether an attendant with burns knew what he was doing.

On their way to the car, the attendant explained, “Your car needs fluids to keep it cool. Sometimes a leak in your radiator causes it to loose coolant. “If it’s a little leak, it’s not much of a problem. You’ll just have to keep refilling what you’re losing.”

Jen remembered the spots of liquid showing up under her care lately.

“Your car needs fluids to keep it cool.” Jen popped the hood.

The attendant pointed to a large semi-clear plastic container labeled “coolant overflow.” He said that usually this is filled with antifreeze and water. “You see where the line is that says hot? That’s where the coolant should be when the car is hot. Jen looked down into the plastic container straining to see anything remotely wet but it looked completely dry. “This is your problem,” said the attendant. Jen bought some antifreeze from the gas station.

“You’ll need to start the car,” declared the attendant. Surprised, Jen turned to the pages describing how to add coolant and continued reading.

Step 1: Find the coolant overflow.

Step 2: Open the cap and add coolant to the coolant container. Coolant is a mixture of antifreeze and water. In a pinch, it is ok to add only water or antifreeze.

Jen turned on the water hose and prepared to pour the two fluids into the coolant tank.

“Don’t put it in just yet,” the attendant cautioned. “I told you, you’ll want to start the car.”

“Why?” she asked. “Won’t it hurt the car if there’s no coolant?”

She looked in her manual.

Caution: If the car is still warm, turn the engine on while adding water and/or antifreeze to circulate and warm the cold coolant and prevent a cracked engine block.

Step 3: Put the cap back on the coolant reservoir.

Jen handed the antifreeze and the hose to him and moved to start the car. She started the car and then moved back to the front of the car while he poured the antifreeze into the coolant container.

When he was done, he handed the remainder of the antifreeze to her. “You’ll want to keep an eye on the temperature to make sure there isn’t a leak in your cooling system. That will need to be fixed by a mechanic.”

“Thank you so much,” said Jen. “You’re a lifesaver!”

“Be safe,” he called over his shoulder.

Jen climbed back into the car. The temperature gauge was improving. She would have quite a story to tell her sister when she finally arrived.

Dan was tired from his long week at work and looked forward to spending the upcoming three-day weekend driving through the mountains. On his drive home from work, he thought about what he should pack but he was distracted by his engine sounding a bit rough. With a frown, he decided to call his friend Joe the mechanic when he got home to ask if he had time to look at his engine. Joe told him to come on over so Dan drove his car to Joe's house. Joe, still in his coveralls from his work at the local mechanics shop, was sitting in front of his garage when Dan got there. Dan told Joe that his car had a strange vibration especially when he drove slowly and the car did not seem to run as it normally did when he was increasing his speed.

Joe asked him if he felt like the engine was hesitating. Dan told him that was just what it felt like. Joe nodded and told him it could be a spark plug issue. Dan raised his eyebrows hopefully. That sounded like a problem that would not be too hard to fix. Dan asked Joe what he should do to determine if that was the problem. Joe told him first to pop the hood and start the car. Dan gladly did so. Joe stared at the engine for a few moments before he motioned for him to turn off the car. Joe confirmed that it was likely a spark plug issue. He could both see and hear the vibration in the way the engine ran.

Now he had to figure out if it was a problem with the plug itself, or with the wires that connect the plug to the distributer. After saying that, he went into his garage for a moment and appeared with a rag and a wrench. He explained that needed a deep socket wrench to get at the plugs. Dan always liked asking Joe for car help because Joe tended to explain what he was fixing so Dan might be able to fix it next time on his own.

True to form, Joe waved Dan over and leaned over the engine. He pointed to four black tubes near the rear of the engine and told Dan that these were the wires for the spark plugs. He then pointed to the end of the wires that had a thicker rubber cover. Those thicker rubber parts are called boots. The boot covers up the spark plug. Joe grabbed ahold of the rubber boot and pulled it away from the engine. Joe warned Dan that it was important to pull only on the boot because if you pull on the wire itself you might cause damage to the wire.

The boot revealed a small metal protrusion. Dan asked if this was the spark plug. Joe nodded but said it would be easier to see when he pulled it out. Joe took the wrench and started unscrewing the spark plug from the engine. Joe used the rag to hold up a metal piece a couple of inches long with a white ceramic casing around the middle. He told Dan that this was a spark plug and handed the spark plug and rag to Dan. He warned him it would be hot. Dan turned the spark plug around and examined it. He wondered aloud why some of it was metal and some was a kind of plastic. Joe pointed out that the white part was ceramic, not plastic and said that it was to insulate it from the engine. If the metal touches the engine, the plug would be grounded and it would not spark as it is supposed to. The metal part at the base of the plug is the where the spark jumps to ignite the gas in the cylinder. Joe turned the plug on its end where there was a tiny metal part that curved up like a hook. There was a tiny space between where the hook ended its curve and the rest of the metal tip. Joe told him that this is where most spark plugs have issues. If the gap between that tiny hook and the rest of the spark plug is not the right distance, the spark plug might misfire. When there is corrosion, the spark is interrupted and does not fire correctly. The gap is different for different cars and since spark plugs are not very expensive, it is usually easier just to buy a replacement. Dan asked if the gap was ok on the one he held. Joe nodded. He told Dan that if the plug had issues, there might be carbon buildup meaning there would be white corrosion around the bottom, or there might be oil on the plug, which would be black in color. There was nothing wrong with the one they were looking at.

Joe took the spark plug back from Dan and put it back in the engine. He then began to unscrew and examine the rest of the spark plugs one by one. On the fourth and last spark plug, they saw quite a bit of white around the metal hook. Joe told him they should run down to the auto parts store and get a new one. They took Joe's car and told the clerk at the store the make, model, and year of Dan's car. They also had the old spark plug in hand to compare with the new one. The clerk found them the right spark plug and the two friends went back to Joe's house. Joe gave the new spark plug and the wrench to Dan. He wanted to see if Dan could put in the new plug on his own. Dan twisted the spark plug into place and then put the rubber boot back over the spark plug. Joe pointed to the driver's seat and Dan jumped in to start the car. The two friends listened to the engine roar for a while. Dan said that the engine sounded much better. Joe agreed. Dan drove off much happier with his car ready to start his weekend in the mountains.

Dan had just finished a long week and was looking forward to spending the upcoming three-day weekend in the mountains. While his mind was focused on what he should pack, he started to notice that his engine sounded a bit rough.

Dan frowned and decided he ought to have his friend the mechanic look at it.

Dan called Joe when he got home. "Hey Joe," Dan said when Joe picked up the phone. "I'm having some engine issues. Do you mind taking a look at it?"

"Sure," Joe agreed. "I've got some time right now, bring it on over."

Dan pulled up in front of Joe's house and saw his friend sitting in front of his garage.

"What seems to be the problem?" asked Joe as Dan stepped onto the driveway.

Dan turned to frown at his car. "There seems to be a strange vibration especially when I'm driving slower." Dan's frown deepened. "It just feels like the car doesn't respond normally when I'm accelerating."

Joe nodded and asked, "Does it feel like the car is hesitating?"

Dan's head jerked up, "Yeah, that's exactly what it feels like."

Joe nodded again, "It sounds to me like you've got a problem with a spark plug."

"That doesn't sound like too big of a problem," said Dan.

"No," agreed Joe. "It's a pretty simple fix if that's the issue."

"What do we do first?"

"First," answered Joe, "you pop the hood and start the car."

Dan gladly did both, then waited while Joe stared at the engine.

"Yep," said Joe. "I can see and hear the vibration in the engine."

"Wow, it's even more obvious with the hood open like that."

"Now we have to see if it's an issue with the spark plug itself or the wires that connect it to the distributer. "I'll be right back," he said before he disappeared into his garage. By the time Dan turned off the car, Joe was back with a towel and wrench in hand.

"What's that for?"

"We'll need a deep socket wrench to get at the plugs."

"You're going to explain how to do this correct?"

"Of course." grinned Joe. "Let's get started."

Dan grinned back and joined Joe in front of his car's engine.

"See these four black tubes near the back of your engine? These are wires for the spark plugs."

"What are those thicker portions over top of the tubes?" asked Dan.

"Those are called boots and they cover up the spark plug."

Joe grabbed a hold of the rubber boot and pulled it away from the engine. "When you pull the boot off the spark plug, you have to be sure to only pull the boot."

"Why is that?"

"If you pull on the wire itself you might cause damage to the wire," said Joe.

"Only pull on boot, check," said Dan.

Joe smiled then pointed to the metal object that the boot had been covering. "What do you think that is?"

"Well, if the boot covers the spark plug, I'm guessing that's a spark plug."

"Yep," answered Joe, "But you'll be able to see it better after I get it out."

Joe took the wrench and unscrewed the spark plug from the engine. He used a towel to hold up a metal piece a couple of inches long with a white casing around the middle.

“Here’s the spark plug.” he said and handed the spark plug wrapped in a towel to Dan.

“Careful, it’s hot.”

“What is that plastic stuff?”

Joe raised his eyebrows. “If you mean the white casing around the metal part, that’s ceramic.”

Dan turned it around in his hand examining it. “Why is some of it metal and some of it ceramic?”

“You see this white part that surrounds the metal?” said Joe as he pointed to the white ceramic casing. “That insulates it from the engine.”

“Insulates it from what?” asked Dan.

“If the metal touches the engine, the plug would be grounded and it wouldn’t spark like it’s supposed to. The metal part at the base of the plug is the where the spark jumps to ignite the gas in the cylinder.” Joe turned the plug on its end. “Do you see where there is a tiny metal part that curves up like a hook?”

Dan nodded.

“Do you see a tiny space between where the hook ends its curve and the rest of the metal tip?”

Dan nodded again.

“This is where most spark plugs have issues.”

“Why is that?” asked Dan.

Joe pointed to the hook as he continued. "If the gap between that tiny hook and the rest of the spark plug isn't the right distance, the spark plug might misfire."

"So all spark plugs need this gap?"

"Yep, and when there is corrosion, the spark is interrupted and doesn't fire correctly. The gap is different for different cars."

"Do we fix it or buy a new one?"

Joe shrugged, "Since spark plugs aren't especially expensive it's usually easier to just buy a replacement."

"Is the gap ok on the one I'm holding?"

Joe nodded. "If the plug had issues, there might be carbon buildup meaning there would be white corrosion around the bottom, or there might be black oil on the plug."

"I don't see anything either white or black."

"I don't either," said Joe. "There's nothing wrong with this one."

Joe took the spark plug and started putting it back in the engine.

"Next we check the rest of the spark plugs to see if there's anything wrong with them."

He then proceeded to unscrew and examine the rest of the spark plugs one by one.

"Only one left," Dan commented when Joe had already looked at three plugs.

"And the fourth one is the one we've been looking for." said Joe as he held up a spark plug. "Do you see the white stuff that's surrounding the metal hook?"

"That's the corrosion you were describing before."

"Yep, and now we run down to the auto parts store and get a replacement."

"Should we take this one with us?"

"Yeah, that way we can be sure they give us the right one that fits in your car."

They took Joe’s car and told the store clerk the make, model, and year of Dan’s car. The clerk found them the right spark plug and the two friends returned to Joe’s house.

Joe handed the new spark plug and the wrench to Dan. “Why don’t you try to put the new one in?”

“Sure, I think I’m up for it,” answered Dan. He twisted the spark plug into place and pushed the rubber boot back over the spark plug.

“Why don’t you start it up?” directed Joe.

Dan jumped in the driver’s seat and turned on the car.

The two friends listened to the engine roar for a while.

“That sounds so much better!” said Dan.

Joe nodded in agreement, “You’re all set.”

“Thanks so much!”

“No problem.”

Dan drove off much happier with his car, ready to start his weekend in the mountains.

Dan had just finished a long week and was looking forward to spending the upcoming three-day weekend driving through the mountains. While his mind was focused on what he should pack, he started to notice that his engine sounded a bit rough.

Dan frowned and decided he ought to have his friend the mechanic look at it to see what was wrong.

Dan called Joe when he got home. “Hey Joe,” Dan said when Joe picked up the phone. “I’m having some issues with my engine. Do you have some time to take a look at it?”

“Sure,” Joe agreed. “I’ve got some time right now. Why don’t you bring it on over.”

When Dan pulled up in front of Joe’s house, he saw his friend sitting in front of his garage still dressed in his coveralls from the mechanics shop he worked in.

“What seems to be the problem?” asked Joe as Dan stepped out onto the driveway.

Dan turned to frown at his car. “There seems to be a strange vibration especially when I’m driving slower.” Dan’s frown deepened. “I’m not sure exactly what it is. It just feels like the car doesn’t respond like it normally does when I’m accelerating.”

Joe nodded and asked, “Does it feel like the car is hesitating?”

Dan’s head jerked up. “Yeah, that's exactly what it feels like.”

Joe nodded again. “It sounds to me like you’ve got a problem with a spark plug.”

“That doesn’t sound like too big of a problem.” said Dan.

“No,” agreed Joe. “It’s a pretty simple fix if that’s the issue.”

“So what do we do first?”

“First,” answered Joe, “you pop the hood and start the car.”

Dan gladly did both. While Joe stood at the engine, Dan flipped open his car repair book to the section on working with spark plugs.

“Yep.” said Joe. “I can see and hear the vibration in the engine.”

“Wow, it’s even more obvious with the hood open like that.”

“Now we have to see if it’s an issue with the spark plug itself or the wires that connect it to the distributer. “I’ll be right back.” He said before he disappeared into his garage. By the time Dan turned off the car, Joe was back with a towel and wrench in hand. He also held a repair book, which he tossed to Dan. “Why don’t you follow along in this book?”

Dan grinned at his friend and flipped through the book until he saw a section on spark plugs.

Step 1: locate the spark plug wires. There should be either 4 or 6 depending on if your car is a 4 cylinder or a 6 cylinder.

Step 2: Follow the wires to where they connect to the distributer. There will be a boot on the end of the wires that covers the spark plug. The boot will be thicker than the wire.

Step 3: Remove the wire plugs from the actual spark plugs. Do not pull on the wires itself as you might damage them. Just pull on the rubber housing that fits on the spark plugs.

Step 4: use a deep socket wrench to unscrew the spark plugs. The spark plug is a metal piece a couple of inches long with a white ceramic casing around the middle. The white part that surrounds the metal insulates the spark plug from the engine. If the metal touches the engine, the plug would be grounded and it wouldn’t spark as it’s supposed to. The metal part at the base of the plug is the where the spark jumps to ignite the gas in the cylinder. If your engine is still warm, the spark plug will be hot. Handle with caution.

Joe held the plug in a towel and turned it on its end. “Do you see where there is a tiny metal part that curved up like a hook?”

Dan nodded.

“Do you see where there is a tiny space between where the hook ended its curve and the rest of the metal tip?”

Dan nodded again.

“This is where most spark plugs have issues.”

Dan looked back into his book to see what the hook had to do with spark plug problems.

If the gap between that tiny hook and the rest of the spark plug isn’t the right distance, the spark plug might misfire. When there is corrosion, the spark is interrupted and doesn’t fire correctly. The gap is different for different cars. Spark plugs aren’t very expensive so it’s usually easier just to buy a replacement.

Step 5: A bad spark plug might have carbon buildup meaning there would be white corrosion around the top, or there might be oil on the plug, which would be black in color.

Dan looked at the spark plug Joe was holding. He didn’t see anything wrong with the plug.

Joe started putting the spark plug back in the engine.

Step 6: Check all of the spark plugs to make sure there is no corrosion or oil.

When Joe pulled out the fourth spark plug, they saw quite a bit of white surrounding the metal hook.

Step 7: If you find a spark plug with a problem, you should replace the spark plug. Tell a local auto supply store the make and model of your car so they can get you the right spark plug for your car. You may also want to bring in the old spark plug.

Joe and Dan took Joe's car down to the auto store for a replacement.

When the two of them were back at Joe's house with the new spark plug in hand, Joe turned to Dan and handed him the wrench.

"Why don't you try to put the new one in?"

"All right, I think I'm up for it." answered Dan. He took one more quick look at his repair book.

Step 8: twist the spark plug into place using a deep socket wrench

Step 9: push the rubber boot back over the spark plug.

Step 10: turn the car on to see if the engine sounds better.

Dan did as the book instructed. After Dan turned on the engine, the two friends listened to the engine roar for a while.

"That sounds so much better!" said Dan.

Joe nodded in agreement. "You're all set."

"Thanks so much!"

"No problem."

Dan drove off much happier with his car, ready to start his weekend in the mountains.

Appendix I – Questions Used for Experimental Data

True Questions Version 1

	Overheated Car	Car Won't Start	Rough Engine
1	If coolant is added, Then the car will be cool (LE)	If the car has a dead battery, you can fix it Without a mechanic (LE)	If you remove a bad spark plug, Then they were corroded (LE)
2	If the car is cool, you can access The car's radiator (E)	If jumper cables are properly connected, The last clamp will be black (E)	If you find a white coating on a spark plug you need, To replace the spark plug (E)
3	If are looking for the coolant tank, Then look for a plastic container (LE)	If you are looking for car batteries, Then look for a rectangular box (LE)	If you are looking for spark plugs casing, Then look for a ceramic cover (LE)
4	If you use water or antifreeze, Then the car engine could cool down (E)	If your car battery is not working, Fix it with someone's battery (E)	If the engine hesitates, Then the spark plugs could be bad (E)
5	If an instrument needle is moving into the red, Then the car temperature could be high (LE)	If there is no sound or lights when you turn the key, Then you might have a dead car battery (LE)	If you must unscrew spark plugs, Then you need to use a deep socket wrench (LE)

E = essential   LE = less essential

True Questions Version 2

	Overheated Car	Car Won't Start	Rough Engine
6	If your car leaks, Then you could refill the leaky tank (E)	If fourth jumper handle attaches to engine frame, Then you could observe a tiny spark (E)	If you have a corroded spark plug, Then you could detect a rough engine (E)
7	When your car is overheating, Turn on the heater (E)	When attaching first jumper cable, attach it to The dead battery (E)	When buying a replacement spark plug, know the Car's make and model (E)
8	If you add cool liquids into a warm car, Then you should start the car (E)	If you are attaching the fourth jumper cable, Use a metal surface (E)	If you pull off spark plug wires, You should pull from the boot (E)
9	If the temperature of the car does not improve after adding coolant, Check for radiator leak (LE)	If you jump a car's battery, Then you should rev the engine (LE)	If the spark plugs are corrosion free, Then check the spark plug wires (LE)
10	To find the coolant container, Then look for plastic (LE)	To find the bolt near the positive sign, Look on battery (LE)	To find spark plugs, Look for spark plug wires (LE)

E = essential   LE = less essential

False Questions Version 2

	Overheated Car	Car Won't Start	Rough Engine
1	If coolant is added, Then the car will be hot	If the car needs a jump start, you need, To see a mechanic	If you remove the boot from a spark plug, You will see corrosion
2	If the car is hot, you can access The car's radiator	If jumper cables are properly connected, Then the car will not start	If you need to screw in spark plugs, you need to have Help from a mechanic
3	If you are looking for the coolant tank, Then look for a metal container	If you are looking for car batteries, Look for a circular container	If you are looking for spark plugs, Then look for a rubber container
4	If you need to cool a car down, You need your spark plugs changed	If you need to jump start your car, You first should let your car cool down	If you see smoke coming from the engine, Then the spark plugs could be bad
5	If an instrument needle is moving into the red, Then the car temperature could be cool	If there is no sound or lights when you turn the key, Then you will need to buy a new spark plug	If you must unscrew spark plugs, Then you can grab the spark plug with bare hands

False Questions Version 1

	Overheated Car	Car Won't Start	Rough Engine
6	If your car has too much oil, Then your car may start to overheat	If fourth handle attaches to engine frame, Then you could see a very large spark	If you have too many boots on your spark plugs, Then you could detect a rough engine
7	When your car is overheating, Then turn on the fan	When attaching the first jumper cable, attach it to the Working battery	When buying a replacement spark plug, know the Color of spark plug
8	If you add cool liquids into a warm car, You should turn on the lights	If you are attaching the fourth jumper cable, Check for a negative sign.	If you pull off spark plug wires, You should pull from the wire
9	If the temperature of the car does not improve after coolant, Check spark plugs for problems	If you jump a car's battery, Then you should add more coolant	If the spark plugs are corrosion free, Then there might not be a spark
10	To find the coolant container, Try inside the trunk	To find the bolt near the positive sign, Look inside the trunk	To find spark plugs, Look for coolant tank

Appendix J – Qualitative Questions Used in Experiment

Overheated Car

Why should you turn on the heat when your car is overheating?

Why are little leaks not a big problem?

Why would putting a cool liquid in a warm car be a problem?

Start Car

Why do you keep the car running after you jump it?

Why do you press on the gas when jumping a car?

Why is it important to attach the last handle to a metal surface other than the battery?

Rough Engine

Why would you take the spark plug out of the engine?

Why does the spark plug have a ceramic casing?

Why is the gap important?

Appendix K – Demographics Survey Used in the Experiment

Disclaimer – different cars have different configurations and you should consult your manual before attempting to fix your car.

Circle your response to the following questions:

How much experience have you had changing a brake light prior to this experiment?

Lots – Some – Average – Little – None

How much experience have you had with an overheated car prior to this experiment?

Lots – Some – Average – Little – None

How much experience have you had with a car that won't start prior to this experiment?

Lots – Some – Average – Little – None

How much mechanical experience do you have with cars?

Lots – Some – Average – Little – None

Gender ___

Appendix L – Figures and Tables for Experimental Data

Table 46

Split-plot ANOVA Total Response Time – 4 Story Types

	df	SS	Mean Square	*F*	*p*
NV	1	4484112.37	4484112.37	4.03	0.047
ORDER	5	3880995.02	776199.00	0.7	0.627
STYPE	3	7294254.58	2431418.19	2.18	0.094
NV*ORDER	5	10529438.84	2105887.77	1.89	0.102
ORDER*STYPE	15	27520674.13	1834711.61	1.65	0.073
NV*STYPE	3	3788816.76	1262938.92	1.13	0.339
NV*ORDER*STYPE	15	15340373.16	1022691.54	0.92	0.547
SUB(NV*ORDER*STYPE)	109	121416821.70	1113915.80		
COVER	2	369320.84	184660.42	0.9	0.410
STYPE*COVER	6	1678416.48	279736.08	1.36	0.233
NV*COVER	2	1676875.34	838437.67	4.07	0.018
ORDER*COVER	10	39335449.84	3933544.98	19.1	<.0001
NV*ORDER*COVER	10	3330561.32	333056.13	1.62	0.103
ORDER*STYPE*COVER	30	6349406.34	211646.88	1.03	0.433
NV*ORDER*STYPE*COVER	30	5318417.86	177280.60	0.86	0.678
SUB*COV(NV*ORD*STYPE)	218	44898165.30	205954.90		
TOTAL	470	297949209.70	633934.50		

Note.

SUB = Subject — COV = Cover

ORD = Order — In all experimental groups n = 3

STYPE = Story type — In all control groups n = 4, but one group had n = 5

NV = Version — Where groups are defined by version*order*stype

Table 47

Split-plot ANOVA Table Proportion Correct – 3 Story Types

	df	SS	Mean Square	*F*	*P*
VERSION	1	0.0005	0.00049383	0.02	0.8803
ORDER	5	0.1437	0.02874074	1.33	0.2620
STYPE	2	0.0946	0.04731481	2.19	0.1197
VERSION*ORDER	5	0.0847	0.01693827	0.78	0.5653
ORDER*STYPE	10	0.1872	0.01872222	0.87	0.5690
VERSION*STYPE	2	0.0652	0.03262346	1.51	0.2283
VERSION*ORDER*STYPE	10	0.0662	0.00662346	0.31	0.9774
SUBJ(VER*ORDER*STYPE)	72	1.5578	0.02163580		
COVER	2	0.3413	0.17064815	11.44	<.0001
STYPE*COVER	4	0.0541	0.01351852	0.91	0.4623
VERSION*COVER	2	0.6897	0.34484568	23.11	<.0001
ORDER*COVER	10	0.1528	0.01527778	1.02	0.4264
VERSION*ORD*COVER	10	0.0962	0.00962346	0.64	0.7733
ORD*STYPE*COVER	20	0.1996	0.00998148	0.67	0.8513
VER*ORD*STYPE*COVER	20	0.1106	0.00553086	0.37	0.9938
SUB*COV(VER*ORD*STY)	144	2.14889	0.01492284		
TOTAL	323	6.0200			

Note.

n = 3

SUB = Subject

ORD = Order

STY = Story type

STYPE = Story type

VER = Version

COV = Cover

Table 48

Split-plot ANOVA Table Proportion Correct without Reading Level – 3 Story Types

	Df	SS	Mean Square	*F*	*p*
VERSION	1	0.0005	0.000494	0.02	0.880
ORDER	5	0.1437	0.028741	1.33	0.262
STYPE	2	0.1522	0.076124	3.52	0.035
VERSION*ORDER	5	0.0847	0.016938	0.78	0.565
ORDER*STYPE	10	0.1872	0.018722	0.87	0.569
VERSION*STYPE	2	0.0652	0.032623	1.51	0.228
VERSION*ORDER*STYPE	10	0.0662	0.006623	0.31	0.977
VER*ORD*STYP*COVER	20	0.1106	0.005530		
SUB(VER*ORD*STYPE)	72	1.5578	0.021636		
COVER	2	0.0172	0.008593	0.58	0.5635
STYPE*COVER	4	0.0432	0.010808	0.72	0.577
VERSION*COVER	2	0.6897	0.344846	23.11	<.0001
ORDER*COVER	10	0.1528	0.015278	1.02	0.426
VERSION*ORDER*COVER	10	0.0962	0.009623	0.64	0.773
ORDER*STYPE*COVER	20	0.1996	0.009981	0.67	0.851
VER*ORD*STYP*COVER	20	0.1106	0.005531	0.37	0.994
COV*SUB(VER*ORD*STY)	144	2.1489	0.014923		
TOTAL	323	5.7427			

Note.

n = 3

SUB = Subject

ORD = Order

STY = Story type

STYPE = Story type

VER = Version

COV = Cover

Table 49

Split-plot ANOVA Total Response Time – 3 Story Types

	df	SS	Mean Square	*F*	*P*
VERSION	1	4586975.27	4586975.27	4.98	0.029
ORDER	5	7151622.72	1430324.54	1.55	0.185
STYPE	2	5813622.31	2906811.15	3.15	0.049
VERSION*ORDER	5	4853671.32	970734.26	1.05	0.394
ORDER*STYPE	10	16488342.81	1648834.28	1.79	0.078
VERSION*STYPE	2	3118496.26	1559248.13	1.69	0.192
VERSION*ORDER*STYPE	10	12610172.30	1261017.23	1.37	0.213
SUB(VER*ORDE*STYP)	72	66363851.28	921720.16		
COVER	2	810463.14	405231.57	2.25	0.109
STYPE*COVER	4	700564.94	175141.24	0.97	0.425
VERSION*COVER	2	1046990.81	523495.41	2.9	0.058
ORDER*COVER	10	29452708.62	2945270.86	16.3	<.0001
VERSION*ORDER*COVER	10	2394425.37	239442.54	1.33	0.221
ORDER*STYPE*COVER	20	4722722.62	236136.13	1.31	0.182
VER*ORD*STYPE*COVER	20	2932899.95	146645.00	0.81	0.695
SUB*COV(VER*ORD*STY)	144	25969633.07	180344.67		
TOTAL	323	189181584.00	585701.50		

Note.

n = 3

SUB = Subject

ORD = Order

STY = Story type

STYPE = Story type

COV = Cover

Table 50

True Means by Version

VERSION	STYPE	MEAN	SE
Version 1	Speech Acts	2429.56	63.77
Version 1	Story Grammar	3064.14	96.14
Version 1	Technical	2777.31	68.08
Version 2	Speech Acts	3111.41	98.94
Version 2	Story Grammar	2965.65	88.36
Version 2	Technical	2844.36	65.14

Table 51

False Means by Version

VERSION	STYPE	MEAN	SE
V1	Speech Acts	2580.372	99.539
V1	Story Grammar	3149.455	156.600
V1	Technical	2758.618	105.245
V2	Speech Acts	2957.816	135.062
V2	Story Grammar	3235.586	120.128
V2	Technical	3200.86	91.82

Table 52

Split-plot ANOVA Total Response Time – NS – Control only

	df	SS	Mean Square	*F*	*p*
VERSION	1	205575.01	205575.01	0.14	0.712
ORDER	5	7301069.83	1460213.97	0.98	0.442
VERSION*ORDER	5	9313619.83	1862723.97	1.25	0.305
ERROR	37	55052970.47	1487918.12		
COVER	2	432048.64	216024.32	0.84	0.434
COVER*VERSION	2	748229.43	374114.71	1.46	0.238
COVER*ORDER	10	11590719.87	1159071.99	4.53	<.0001
COVER*VERSION*ORDER	10	3492584.85	349258.48	1.37	0.213
ERROR(COVER)	74	18928532.25	255790.98		
TOTAL	146	107369713.40	735409.00		

Note.

In all control groups n = 4, but one group had n = 5

Where groups are defined by version*order*stype

Table 53

Split-Plot ANOVA Table of True and False Questions

STYPE	2	12289605.8	6144802.9	3.03	0.0545
VERSION	1	10898384.3	10898384.3	5.37	0.0233
STYPE*VERSION	2	7753664.1	3876832.1	1.91	0.1553
ORDER	5	14701350.6	2940270.1	1.45	0.2171
STYPE*ORDER	10	33725971.8	3372597.2	1.66	0.1065
VERSION*ORDER	5	10647258.3	2129451.7	1.05	0.3953
STYPE*VERSION*ORDER	10	25116980.9	2511698.1	1.24	0.282
ERROR	72	146026840.4	2028150.6		
ANSWER	1	2144093.1	2144093.1	4.53	0.037
ANSWER*STYPE	2	1100238.7	550119.4	1.16	0.3183
ANSWER*VERSION	1	293528.6	293528.6	0.62	0.433
ANSWER*STYPE*VERSION	2	3317863.9	1658932.0	3.51	0.035
ANSWER*ORDER	5	1861709.6	372341.9	0.79	0.5622
ANSWER*STYPE*ORDER	10	4116846.2	411684.6	0.87	0.564
ANSWER*VERSION*ORDER	5	8844329.9	1768866.0	3.74	0.005
ANSWER*STYPE*VERSION*ORDER	10	2911584.2	291158.4	0.62	0.7957
ERROR(ANSWER)	72	34051100.5	472932.0		
COVER	2	3290244.0	1645122.0	4.3	0.015
COVER*STYPE	4	1414602.4	353650.6	0.93	0.4512
COVER*VERSION	2	2815243.7	1407621.8	3.68	0.0276
COVER*STYPE*VERSION	4	587731.8	146933.0	0.38	0.820
COVER*ORDER	10	62087547.6	6208754.8	16.2	<.0001
COVER*STYPE*ORDER	20	12721126.8	636056.3	1.66	0.046
COVER*VERSION*ORDER	10	4715912.8	471591.3	1.23	0.275
COVER*STYPE*VERSION*ORDER	20	7046022.2	352301.1	0.92	0.561
ERROR(COVER)	144	55052483.07	382308.9		

Note.

STYPE = Story type

Version Effects:

Table 54

Total Response Time by Story Type - Separated by Version

	Version 1	Version 2
Speech Acts	2512.467	3003.153
Story Grammar	3077.628	3089.989
Technical	2790.430	2994.014

Note. Response times in milliseconds

F(2, 144) = 3.15, *p* < .05

Figure 10

Total Response Time by Version

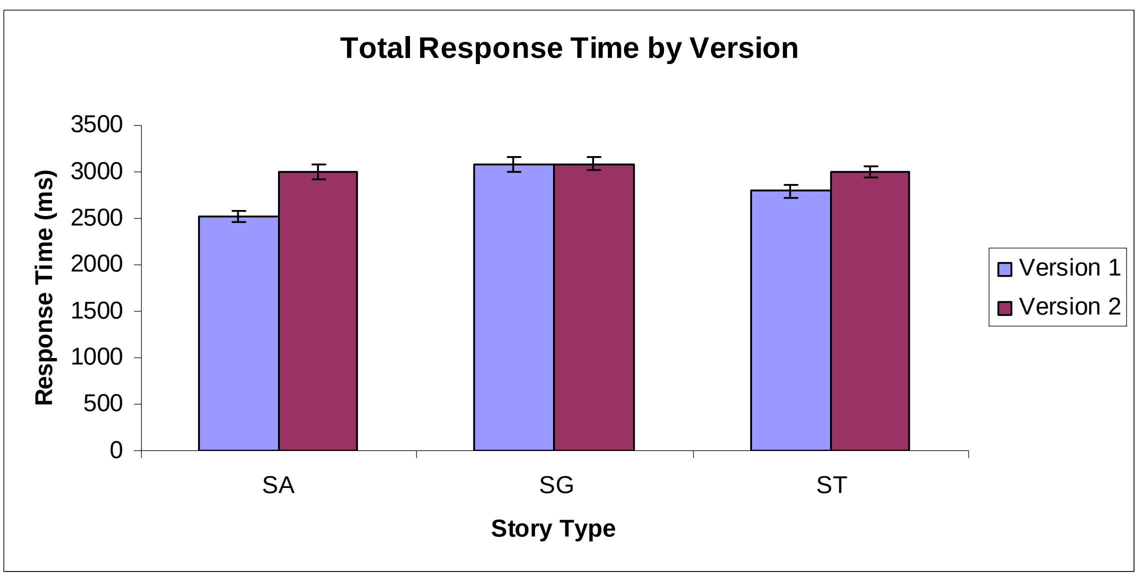

Table 55

Version by Story Type for True Responses

Version	Story type	Mean	SE
Version 1	Speech Acts	2429.56	63.77
Version 1	Story Grammar	3064.14	96.14
Version 1	Technical	2777.31	68.08
Version 2	Speech Acts	3111.41	98.94
Version 2	Story Grammar	2965.66	88.36
Version 2	Technical	2844.36	65.14

Note. Response times in milliseconds

Table 56

Cover by Version

	Version 1	Version 2
Overheated Car	2750.567	3101.996
Start Problem	2766.390	2802.753
Rough Engine	2754.056	3016.682

Appendix M – Story Measures

The measures of grade level and reading level came from indices developed by Flesch (1948). He also designed another measure of text several years after the initial two measures. This third measure he called the 'human interest' score. According to Flesch's paper, composing the human interest score consists of identifying an arbitrary selection of 100 words of text and measuring the number of personal words and personal sentences in that portion of text. Personal words are all nouns that suggest a gender and all pronouns (expect neutral pronouns such as 'people'). Personal sentences measures conversations in text, specifically it is a numeration of any spoken communication denoted by quotation marks or comments directly to the reader. The human interest score is composed of a weighted count of personal words and personal sentences.

If one were to continue attempting to classify stories in an arbitrary manner, this score might be a closer measure of a story's essence than the reading or grade level scores. It does support the importance of conversational elements in stories, which the experimental data here also suggests. However, as you can see from the numbers in Table 37, the pattern of scores would suggest an interaction of cover with story type, something not replicated in the results of the experiment.

The importance of an abstract measure of stories is not the goal of this paper. In fact, the abstract categorizations compiled by the story grammar researchers are an example of how this approach to stories is less than effective. Instead of pulling away the context of a story, it is important to let the richness of detail and context inherent in stories drive our understanding of stories.

Table 57

Flesch's Human Interest Score

	Overheated	Start Problem	Rough Engine
Speech Acts	38.234	82.168	45.818
Story Grammar	18.799	56.723	11.533
Technical	36.350	43.620	18.175