Computers in Human Behavior 36 (2014) 41–47

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

The effects of text presentation format on reading comprehension and video game performance

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ARTICLE INFO

Article history:
Available online 13 April 2014

Keywords:
Video game-based training
Military
Mobile devices
Reading comprehension
Rapid serial visual presentation

ABSTRACT

The military has used video games to help geographically distributed military teams develop specific skills in a safe, controlled environment. Military trainers have also used hand-held devices and rapid serial visual presentation (RSVP) of text and graphics for training and mission planning. This research continued previous work investigating the influence of RSVP of intelligence reports on task performance, reading comprehension, and affect. Seventy-eight participants moved through a video game to find a target avatar as quickly as possible based on intelligence reports. There were two presentation styles (RSVP or traditional) and two intelligence formats (content-relevant words or full sentences). Differences in task performance, reading comprehension, and affect occurred as a function of text presentation. Participants in the RSVP group found the medic more quickly when reading full sentences than when reading only content words. Individuals reading traditional text of content words scored higher on comprehension tests than when reading either RSVP format. Participants also found RSVP tasks to be more challenging and more engaging than traditional text formats. These results suggest researchers and trainers should continue to investigate RSVP to determine its applicability for training other skills.

1. Introduction

Hand-held devices (e.g., tablets and cell phones) have gained widespread use across populations, tasks, and environments because they provide limited space for text and other visual presentation. In the last few years, research has been conducted to investigate the usability of such devices. Researchers have explored ways to present text in such a way that would improve readability without reducing reading speed and comprehension. One form of visual presentation on small devices is rapid serial visual presentation (RSVP). RSVP is the presentation of brief messages at high rates in small text segments on a screen. Text may be presented one or more words per frame in a fixed location on a computer or hand-held device screen. RSVP has shown promise on small screens for a wide range of tasks, including research tasks and reading tasks for visually impaired and dyslexic individuals (e.g. Muter, 1996; Muter et al., 1988). Rapidly displaying text segments in a serial fashion may reduce eye movements, increase attentional focus, and reduce cognitive processing (Castelhano & Muter, 2001; Joula, Ward, & McNamara, 1982; Potter, 1984). Other research suggests that RSVP reading rates may be faster due to decreased eye movements, but individuals still find reading RSVP text to be uncomfortable and cognitively demanding (Castelhano & Muter, 2001; Rubin & Turano, 1992). The Air Force has investigated the use of RSVP of text and images as a valid training method for over twenty years (Boff, 1988; Skelley et al., 2000). Today, RSVP is available to the public through computer and hand-held device applications.

The US military uses simulations such as virtual environments and video games for nearly every facet of a Soldier's life, from teamwork to military logistics to strategy to firearms. The military uses virtual environments to represent work environments for training personnel to pilot aircraft, drive ground vehicles, navigate buildings, and handle weapons (Hays, 2005). The US military is the world's largest user of digital game-based learning applications (Prensky, 2001). These types of simulations have the potential to be safe, cost effective, and highly motivating for soldiers. Video games can also simulate different kinds of real scenarios and environments, especially situations that can pose a physical danger to players. Researchers and trainers are able to modify certain video games without using programming expertise to meet the requirements of research or training applications (Frey, Hartig, Ketzel, Zinkernagel, & Moosbrugger, 2007). There is disagreement about the observed and desired levels of skill transfer from video game-based training to real world tasks (Hays, 2005). However,

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http://dx.doi.org/10.1016/j.chb.2014.03.039
0747-5632/

there is empirical evidence to support the use of games for enhancing learning and training (see Salas & Cannon-Bowers, 2001 for a review).

1.1. Purpose of the present study

There may be benefits associated with using RSVP in hand-held devices for training real world tasks such as those performed by the military. The military equips deployed personnel with technology based on tablets, smartphones, and gaming toolkits. These devices are either official Multi-Function Displays (MFDs) or upgraded proprietary hand-held devices such as Apple's™ iPods and iPads. An example of these devices would be those developed by the Army's Connecting Soldiers to Digital Applications (CSDA) program. Tablets and other hand-held devices offer Just-In-Time (JIT) training and the simulation of complex procedures and tasks. There are also recent advances in game toolkits for these devices that allow developers to design serious gaming platforms for trainers to employ in the field for personnel. Using a hand-held device with a game toolkit, maintenance personnel can practice routine tasks from a first person perspective in the field following simulation training in the classroom (Morris, 2011; Vision Gain (August, 2010). Researchers' investigations are warranted to determine whether RSVP can also increase attention and reduce training time in more applied contexts while maintaining reading comprehension levels comparable to regular paragraph text formats. The work described here focuses on the influence of gaming experience and text presentation on task performance, attitudes, and reading comprehension in a video game search task.

2. Theory

2.1. Comprehension as a function of text presentation format

Comprehension of single words and full paragraphs is possible with RSVP, but reading comprehension and retention is often reduced when the rate of presentation increases (e.g., Chen & Chien, 2007; Chen, Healy, & Bourne, 1985; Duggan & Payne, 2009; Just & Carpenter, 1980; Potter, 1984). Researchers have investigated a wide variety of presentation rates from 3.3 to 20 words per second. Research suggests individuals are able to readily process text that is presented at rates that fall within eight to twelve words per second (e.g., Joula et al., 1982; Potter, Kroll, & Harris, 1980). Rates faster than twelve words per second may lead to comprehension and retention decrements (e.g., Joula et al., 1982; Potter et al., 1980). Russell, James, and Cohlmia (2002) found no differences between comprehension of RSVP at a rate of 250 words per minute and a usual hand-held device text (paragraph presentation) format. However, they did find reading comprehension decrements with increases in RSVP rates. Performance was incrementally worse when participants were presented RSVP text at 450 or 650 words per minute. The normal rate of reading using traditional paragraph formats is generally slower than RSVP of text, except in the case of speed reading which is similar to RSVP (Duggan & Payne, 2009; Masson, 1983). The ability for readers to comprehend RSVP at moderate rates could indicate that readers generally skim read, especially when under time pressure (Just & Carpenter, 1980; Masson, 1983).

Given the varying design and results of previous investigations, it is difficult to determine an ideal RSVP rate and presentation style based on the current literature. In particular, little research up to this point has focused on the successful application of RSVP comprehension to a subsequent task. In a study assessing task performance as a function of information presentation in a video game-based architecture, it was concluded that eight words per second may be too rapid for reading comprehension in that context and RSVP of four words per second may elicit performance comparable to traditional text presentation formats (Proaps & Bliss, 2013). It is important to extend this area of research to find the optimal RSVP presentation within more applied contexts.

2.2. Comprehension as a function of semantically related words versus full sentences

Some researchers have investigated whether showing multiple words in a single frame during RSVP will improve reading comprehension. In one experiment, participants shown six word sentences at one word per frame and sixteen words per second were able to recall three or four words per sentence correctly, but increased sentence complexity reduced this effect (Forster, 1970). Studies examining proofreading and skim reading have also found that individuals process function words differently due to their frequency of use (Castelhano & Muter, 2001; Haber & Schindler, 1981; Just & Carpenter, 1980). Duggan and Payne (2009) found no reading comprehension differences between participants who skimmed text and those who read at normal rates in comprehending less critical aspects of the text. Reading studies suggest that processing time varies depending on the type of word displayed. Just, Carpenter, and Woolley (1982) found individuals performing a traditional page reading task fixated on content words 83% of the time and on function words 35% of the time (Castelhano & Muter; 2001). Skelley et al. (2000) found that including irrelevant information in a string of visual items using RSVP led to slower reading performance compared to including only relevant task information, which led to faster responding.

There are limits to individual memory capacity for lists of unrelated objects, such as letters and words (Coltheart, 1999). For example, researchers suggest visual short term memory capacity may range from approximately four chunks to seven plus or minus two chunks (Baddeley, Thomson, & Buchanan, 1975; Conrad & Hull, 1964; Cowan, 2001). Those memory capacity limits become less established as individuals use rehearsal and chunking methods, and they depend on the complexity, length, and similarity of each object presented (Baddeley et al., 1975; Conrad & Hull, 1964; Cowan, 2001; Miller, 1956). Studies suggest that the cohesive organization of text contributes to the meaningful processing and memory of text, particularly due to semantic chunking of words (e.g., Gobet et al., 2001; Kincade & Stange, 1993).

Chunking involves grouping or organizing separate pieces of information into meaningful groups to increase retention in short term memory and recall capacity. Individuals may also use rehearsal to actively maintain information in short-term memory by repeating it mentally. Other research suggests segmenting text into smaller units can improve reading performance across age groups, reading expertise levels, and learning disabilities (e.g., Casteel, 1989; Jandreau, Muncer, & Bever, 1986; Kincade & Stange, 1993; Radebaugh, 1983; Weiss, 1983). The text size, presentation unit, visual structure, and segmentation unit can impact text comprehension with RSVP (Lemarié, Eyrolle, & Cellier, 2008). It is difficult to determine the ideal presentation parameters for RSVP based on the current literature.

Hypothesis 1. Participants presented with content words in the rapid serial visual presentation group would exhibit worse reading comprehension scores than participants presented with full sentences in the traditional text presentation group.

Most research focuses on reading speed and reading comprehension as primary performance measures. Few studies have investigated applied task performance as a function of RSVP comprehension. To address this gap, the ultimate goal of the present