Learning and Individual Differences 32 (2014) 69–79

Contents lists available at ScienceDirect

Learning and Individual Differences

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

Are there gender differences in the cognitive components of adult reading comprehension?

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ARTICLE INFO

Article history:
Received 22 May 2013
Received in revised form 21 January 2014
Accepted 21 March 2014

Keywords:
Gender differences
Reading
Cognitive processes

ABSTRACT

This study examined: (i) whether gender differences exist in the specific cognitive components that are tapped by measures of adult reading comprehension and (ii) whether gender differences exist in the powers of these specific cognitive components to predict reading comprehension. The results revealed a small male advantage for text inferencing and low-knowledge integration, $d = -.36$ and $d = -.28$, but no gender differences in the remaining six cognitive components. They also revealed that high-knowledge integration, text memory, and epistemic belief of learning were more predictive of reading comprehension performance for females than males, whereas word decoding was more predictive of reading comprehension performance for males than females. Taken as a whole, these results suggest that there are few quantitative gender differences in the specific cognitive components that are tapped by measures of adult reading comprehension; however, there are important qualitative gender differences in the predictive powers of these specific cognitive components.

1. Introduction

Over the past 100 years both psychologists and the general public have been fascinated with the idea of gender differences in cognitive abilities (Hyde & McKinley, 1997). The most popular belief is that males possess greater quantitative and visuospatial abilities than females while females possess greater verbal ability than males (Maccoby & Jacklin, 1974). Summaries of meta-analyses however, suggest that gender differences in cognitive abilities may be much more specific in adult populations than is popularly believed (Hyde & McKinley, 1997; Spelke, 2005; see Hyde, 2005 and Halpern et al., 2007 for a discussion of this point). In the domain of quantitative and visuospatial abilities, for example, although males tend to perform better than females on measures of mathematical problem solving, mental rotation, and spatial perception (e.g., Halpern, 2000; Halpern et al., 2007), few, if any, gender differences exist on measures of mathematical computation (i.e., arithmetic), mathematical concepts, and other measures of visuospatial abilities (Halpern et al., 2007; Hyde & McKinley, 1997; Linn & Petersen, 1985). Similarly, in the domain of verbal abilities, although females tend to perform better than males on measures of spelling (Kimura, 1999), word fluency (Halpern, 2000; Kimura, 1999), and language production (Halpern, 2000; Hyde & McKinley, 1997), few if any gender differences exist on measures of vocabulary (Halpern et al., 2007). Indeed, although there is a female advantage on measures of reading comprehension ability when the target population is children or adolescents (Logan & Johnston, 2010; Lynna & Mikk, 2009; Mullis, Martin, Gonzalez, & Kennedy, 2003; Mullis, Martin, Kennedy, & Foy, 2007) few, if any, gender differences exist when the target population is adults (Hyde & Linn, 1988; Hyde & McKinley, 1997).

Nevertheless there are at least two reasons why there is a need to further examine gender differences in reading comprehension, especially when gender differences in the cognitive components of reading are being considered and the target population is adults. First from a practical perspective, determining whether there are gender differences in *specific cognitive components* such as those cognitive components tapped by measures of reading comprehension might provide insight as to why males achieve higher scores than females on standardized tests designed for admissions to colleges, universities, and graduate programs whereas females achieve higher grades (i.e., GPAs) than males in school (Halpern et al., 2007; Mau & Lynn, 2001; also see Halpern, 2004). Second, from a theoretical perspective, researchers argue that gender differences should be understood in terms of cognitive processes rather than the classification or type of task (e.g., verbal, quantitative, visuospatial) (see Halpern, 2004 for a discussion of the *cognitive-processes approach* for examining gender differences in cognitive abilities).

Therefore, one goal of the present study was to determine whether gender differences exist in the specific cognitive components that are typically tapped by measures of adult reading comprehension. For example, are there gender differences in the specific cognitive components that are used to learn explicit and implicit text-based information (i.e., text memory, text inferencing)?; are there gender differences in the specific cognitive components that connect text-based information with information from prior knowledge (i.e., knowledge integration)?; or are there gender differences in the specific cognitive components that decode and identify words (i.e., lower-level word decoding)? The specific cognitive components examined in the present study were higher-level processes, which are used for learning and integrating text (e.g., text memory, text inferencing, knowledge integration, and

http://dx.doi.org/10.1016/j.lindif.2014.03.017
1041-6080/

knowledge access), lower-level processes, which are used for decoding words, and epistemic belief of learning, which is knowledge about learning. This taxonomy of high-low cognitive processes has been adopted in order to delineate the differences between processes that are used to remember, retrieve, and connect ideas of a text (i.e., higher-level processes) and processes that are used to decode words (i.e., lower-level processes). These cognitive components were selected because of their importance for constructing an integrated and coherent representation of a text (e.g., Daneman & Hannon, 2001; Kintsch, 1988, 1998). Additionally, research suggests that measures of higher- and lower-level cognitive processes account for as much as 55% of the variance in reading comprehension performance in an adult population (Hannon, 2012a; Hannon & Daneman, 2001a, 2006, 2009).

A second goal of the present study was to determine whether gender differences exist in the powers of the specific cognitive components to predict measures of adult reading comprehension ability. That is, does text memory predict reading comprehension performance to the same extent for males and females?; does text inferencing predict reading comprehension performance to the same extent for males and females?; does knowledge integration predict reading comprehension performance to the same extent for males and females?; and do lower-level word decoding processes predict reading comprehension performance to the same extent for males and females? Below I briefly review developmental research examining gender differences in reading comprehension performance and its cognitive components. Next I relate this developmental literature to the adult literature that has examined gender differences in verbal abilities. In the final section, I describe the present study.

1.1. Background

National and international assessments consistently observe a gender difference in reading comprehension ability in children (Department for Children, Schools and Families (DCSF) (DCSF), 2008a,b,c; Mullis et al., 2003, 2007). Indeed, international studies examining reading comprehension in 10-year old children have observed a gender difference favoring girls in 35 of 40 participating countries (Mullis et al., 2003, 2007). This gender difference exists regardless of the type of writing system, alphabetic or ideographic orthography (Ming Chui & McBride-Chang, 2006; Mullis et al., 2003, 2007), and it extends well into adolescence (e.g., Ming Chui & McBride-Chang, 2006). Given the importance of reading skill in academics and employment, this "gender gap" potentially has a profound impact on males (Clinton et al., 2012; Riordan, 1999; Wood, 2003).

Reading comprehension, however, is a complex construct that is composed of a number of cognitive component processes (Cain, Oakhill, & Bryant, 2004; Graesser, Singer, & Trabasso, 1994; Hannon, 2012a; Hannon & Daneman, 2001a, 2006, 2009; Hannon & Frias, 2012; McNamara & Magliano, 2009).[1] Indeed, research suggests that reading comprehension is composed of: (i) lower-level processes that identify and decode words (Cunningham, Stanovich, & Wilson, 1990), (ii) higher-level processes that extract explicit information from text (Hannon, 2012a), connect text-based ideas (i.e., text-based inferences: Hannon & Daneman, 2001a), establish text coherence by connecting or bridging text-based ideas with prior knowledge (Singer & Ritchot, 1996), and embellish the text using prior knowledge (e.g., thematic and predictive inferences: Hannon & Daneman, 1998; Long, Oppy, & Seely, 1994), as well as (iii) knowledge about learning (i.e., epistemic belief of learning: Daneman & Hannon, 2001). Consequently, any one or a combination of these components might be a major source of the gender difference in reading comprehension ability.

[1] For this reason, measures of reading comprehension are often labeled as measures of *global verbal abilities* whereas measures of its cognitive components are labeled as measures of *spe verbal abilities* or *specific cognitive components*.

Because of this complexity, a few developmental researchers have begun to examine gender differences in the specific cognitive that are typically tapped by measures of global reading comprehension ability. One surprising finding is that, for children, gender differences in the specific cognitive components are limited to only a small subset of components rather than all of the cognitive components that are part and parcel of reading comprehension. For example, using a think aloud protocol Clinton et al. (2012) examined gender differences in the frequency that grade 4 children generated four cognitive components of reading comprehension, namely re-instatement inferences (i.e., re-instatement of a previous fact to explain a current fact), connective inferences (i.e., inferences that connect concurrent sentences), knowledge-based inferences (i.e., inferences requiring explanations/predictions based on prior knowledge), and text-based memory statements (i.e., paraphrases or repetition of the text). Although Clinton et al. observed that females generated more re-instatement inferences than their male counterparts, they also observed no gender differences in the generation of connective inferences, knowledge-based inferences, or text-based memory statements.

In a subsequent study, Seipel, Clinton, and Carlson (2012) extended the findings of Clinton et al. (2012) by examining whether a gender difference existed in connective inferences that were either semantically- or episodically-based. Although Seipel et al. observed that females generated more episodic connective inferences than their male counterparts, there was no gender difference in semantic connective inferences. Therefore, the combined results of Clinton et al.'s and Seipel et al.'s studies suggest that, for grade 4 children, gender differences in the specific cognitive components of reading comprehension are limited to re-instatement inferences and episodically-based connective inferences.

With respect to adults, to date no study has examined gender differences in the specific cognitive components that are tapped by measures of reading comprehension ability. Thus, from this viewpoint, it is unclear whether gender differences in the specific cognitive components of reading comprehension do or do not exist. Moreover, in the broader context of verbal abilities, the evidence for gender differences is equivocal. On the one hand research suggests that gender differences in an adult population are minimal to non-existent on measures of reading comprehension and vocabulary (e.g., Halpern et al., 2007; Hyde, 2005; Hyde & McKinley, 1997). For the present study, this lack of a relationship between gender and vocabulary is particularly relevant because vocabulary knowledge is highly predictive of adult reading comprehension ability (e.g., Daneman, 1991; Sternberg & Powell, 1983). And because the shared variance between vocabulary knowledge and reading comprehension ability is largely a consequence of specific cognitive components that are common to both constructs (e.g., Hannon & Daneman, 2001a, 2006; Sternberg & Powell, 1983), it is possible that the present study will reveal no gender differences in the specific component processes that are tapped by measures of adult reading comprehension ability.

However other research suggests that there are gender differences in some of the important measures of verbal abilities. For instance, females perform better than males on measures of spelling (e.g., Kimura, 1999), word fluency (e.g., Halpern, 2000; Kimura, 1999), language production (e.g., Halpern, 2000; Hyde & McKinley, 1997), perceptual speed (e.g., Halpern, 2000), and episodic memory (e.g., Guillem & Mograss, 2005; Halpern, 2000). On the other hand, males perform better than females on measures of verbal analogies (e.g., Lim, 1994), deductive reasoning, and analytic reasoning (e.g., Colom, Contreras, Arend, Leal, & Santacreu, 2004). These latter findings are particularly relevant to the present study because other research suggests that measures of the higher-level cognitive components of text inferencing and knowledge integration are predictive of performance on measures of verbal analogies, deductive reasoning, and analytic reasoning (e.g., Hannon & Daneman, 2001a). Thus, it is possible that the present study will reveal male advantages on the higher-level cognitive components of text inferencing and knowledge integration.