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Sex differences in latent cognitive abilities ages 6 to 59: Evidence from the Woodcock–Johnson III tests of cognitive abilities ☆

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Abstract

Sex differences in the latent general and broad cognitive abilities underlying the Woodcock–Johnson Tests of Cognitive Abilities were investigated for children, youth, and adults ages 6 through 59. A developmental, multiple indicator–multiple cause, structural equation model was used to investigate sex differences in latent cognitive abilities as well as developmental changes in these differences across the 6 to 59 age span. Females showed a consistent advantage on the latent processing speed (Gs) factor, and males showed a small, consistent advantage on the latent comprehension–knowledge (Gc) factor. Males also showed an advantage on latent quantitative reasoning (RQ) and visual–spatial ability (Gv) factors at most ages, although the latter was statistically significant only for adults. No statistically significant sex differences were shown on latent auditory processing, short-term memory, long-term retrieval, or fluid reasoning factors. The higher-order, latent *g* factor showed inconsistent differences for children, small, non-significant differences favoring females for adolescents, and fairly consistent statistically significant differences favoring females in adulthood. Findings are inconsistent with developmental theory that suggests males should show an advantage on *g* in adulthood. Supplemental analyses suggested that methodological choices, including the use of latent variables versus composites and methods for dealing with missing data, can affect research findings.

Keywords: Sex differences; Broad cognitive abilities; General intelligence; Structural equation modeling; MIMIC models; Developmental differences

1. Introduction

Despite considerable attention focused to the topic of sex differences in intelligence, a number of inconsistencies concerning the presence, direction, and magnitude of the differences remain. The identification of the ages at which differences typically emerge as well as the pattern of differences from childhood through adulthood is fundamental for understanding the true nature of sex differences in cognitive abilities. The current study examined differences in latent cognitive abilities between males and females on the Woodcock–Johnson III Tests of Cognitive Abilities, while taking into account the developmental changes across ages 6 to 59.

1.1. Sex differences in broad cognitive abilities

Males and females have shown consistent differences in some broad cognitive abilities across the lifespan. In

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general, females have shown an advantage in processing speed (Gs) from childhood through adulthood (Burns & Nettelbeck, 2005; Camarata & Woodcock, 2006; Hedges & Nowell, 1995). Males, in contrast, generally have demonstrated an advantage in broad visual–spatial ability (Gv) and related subtests (Jensen, 1998; Lynn, Fergusson, & Horwood, 2005; Maitland, Intrieri, Schaie, & Willis, 2000; Reynolds, Keith, Ridley, & Patel, in press; Rosén, 1995). Recent findings examining sex differences in some aspects of visual–spatial ability have not favored either sex, however (Camarata & Woodcock, 2006). Thus, it appears that there may be sex differences in specific aspects of spatial ability, such as spatial perception, mental rotation, spatial visualization, or visual memory (Linn & Peterson, 1985; Voyer, Voyer, & Bryden, 1995).

The evidence for sex differences in fluid reasoning (Gf) is mixed. Some evidence suggests that there are no practical differences between males and females from childhood through adulthood on aspects of Gf (Camarata & Woodcock, 2006; Kaufman & Horn, 1996). If fluid reasoning is measured by Progressive Matrices Tests, however, findings from recent studies suggest that adult males show an advantage over adult females on these measures (Lynn, Allik, & Irwing, 2004; Lynn & Irwing, 2004). Males have also shown an advantage on quantitative reasoning (RQ) (Benbow & Stanley, 1980; Jensen, 1998), a component of fluid reasoning (Carroll, 1993; Keith, 2005).

Studies examining crystallized ability (also known as comprehension–knowledge) at the broad ability, composite scale, and subtest level have been inconsistent, with findings depending on the nature of the task. For instance, females have shown an advantage in general verbal ability subtests and word knowledge, whereas males have shown an advantage in verbal analogies and general knowledge (Hyde & Linn, 1988; Lynn, Irwing, & Cammock, 2001). Recent research examining a latent crystallized ability (Gc) factor suggested that when general intelligence was controlled, boys showed a statistically significant advantage through the age of 16 (Reynolds et al., in press).

Less is known about the presence of sex differences in other broad abilities, including short-term memory, long-term memory, and auditory processing; findings from existing studies are also inconsistent. For example, Camarata and Woodcock (2006) reported no sex differences in short-term memory (Gsm), long-term retrieval (Glr), and auditory processing (Ga) composites from childhood through adulthood. A comparison of latent Gsm and Glr factors also showed no significant sex differences when controlling for *g* (Reynolds et al., in press). However, results from other studies suggest differences favoring females in short-term memory (Jensen, 1998; Maitland et al., 2000), long-term memory (Hedges & Nowell, 1995; Johnson & Bouchard, 2007a), and auditory processing (Hulick, 1998).

1.2. Sex differences in general intelligence

Some researchers have argued that there is no significant sex difference in general intelligence (e.g., Jensen, 1998; Mackintosh, 1996), and results from several recent studies have supported this position (e.g., Camarata & Woodcock, 2006; Deary, Strand, Smith, & Fernandes, 2007; Jensen, 1998; van der Sluis et al., 2007; van der Sluis et al., 2006). In contrast, Lynn (1999) has argued that for adults, males should demonstrate an advantage in general intelligence, and several recent findings have supported this position (Deary, Irwing, Der, & Bates, 2006; Irwing & Lynn, 2005; Jackson & Rushton, 2006; Lynn & Irwing, 2004; Lynn, Raine, Venables, Mednick, & Irwing, 2005; Nyborg, 2005).

According to Lynn, sex differences in intelligence need to be considered within the context of human development. Lynn suggested that results from previous studies of sex differences that have been based on children or young adults mask true differences in general intelligence due to differences in maturation (1999). There is a positive correlation between brain size and sex (McDaniel, 2005; Vernon, Wickett, Bazana, & Stelmack, 2000), and males have larger brains, on average, than do women. Thus, if this correlation is the result of a causal process, and one that accounts for between group differences as well as within group differences, then adult males should have an advantage over females in general intelligence. Lynn hypothesized that the male advantage in general intelligence should not emerge until late adolescence or early adulthood because females mature at an earlier age than do males. Specifically, Lynn's developmental theory of intelligence proposed that there should be small or negligible sex differences in general intelligence from ages 8 to 15, but by age 16 males should begin to show an increasing advantage through adulthood. Lynn's theory (1994, 1999) is noteworthy because it is an attempt to resolve an anomaly in the literature: males have larger brains than females, yet there is no observed difference in intelligence between males and females (Ankney, 1992; Rushton, 1992). Lynn has since demonstrated empirical support for his theory, although the ages at which differences emerged varied to some degree (Colom & Lynn, 2004; Lynn, Allik, & Must, 2000). Nevertheless, questions remain regarding how Lynn's developmental