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Occupational segregation and psychological gender differences: How empathizing and systemizing help explain the distribution of men and women into (some) occupations ☆

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ABSTRACT

The proportion of men and women workers varies among occupation types. There are several factors that may contribute to occupational segregation by gender. Using a large U.S. sample ($n = 2149$), we examine the extent to which occupational segregation can be attributed to gender differences in empathizing and systematizing: Psychological dimensions which theorists argue represent meaningful differences between men and women. Of the eight occupational categories for which employee gender and occupation type were associated at the $p < .01$ level, four of these – Construction, Professional/Scientific/Technical fields, Management, and Education – were partially mediated by systemizing and/or empathizing scores, which typically accounted for 10–20% of the observed gender differences. For other areas, like Health, gender differences were not mediated by either measure.

1. Introduction

Some occupation types in the U.S. have a higher proportion of men and some have a higher proportion of women, a phenomenon which has been labeled "occupational gender segregation" (e.g., Alonso-Villar, Del Rio, & Gradin, 2012; Mintz & Krymkowski, 2011). For example, data from U.S. Bureau of Labor Statistics (2012) showed that approximately 9% of workers in construction were women, but that approximately 78% of workers in health services were women. This disparity, in which women are overrepresented in teaching and service jobs while men are overrepresented in technical and laborer jobs, has existed for over 60 years (e.g., Lippa, Preston, & Penner, 2014). Though occupational segregation by gender declined between 1970 and 2009, the decline appears to be occurring at an increasingly diminished pace (Blau, Brummund, & Yung-Hsu Liu, 2012), even though women's overall labor force participation and educational attainment over this time period has increased (e.g., DiPrete & Buchmann, 2006; U.S. Bureau of Labor Statistics, 2009, 2011). Indeed, as of 2001, 31% of men or women (or a combination of thereof) would have to change occupations for there to be total gender equality in occupational distributions (Gabriel & Schmitz, 2007).

For decades, economists, sociologists, psychologists, policy makers, businesses, and feminist scholars have sought to track and understand why U.S. occupations are segregated by gender (e.g., Albelda, 1986; Blau & Jusenius, 1976; Gross, 1968; Jacobs, 1989), due to the implications of occupational segregation for the gender-wage gap, gender equality in opportunities for work, and attracting and developing talent in the workplace (e.g., Blau & Kahn, 2006; Cohen, Huffman, & Knauer, 2009; Maume, 1999). Specifically, researchers have argued that occupational gender segregation is the leading explanation for gender earnings inequality today (Gauchat, Kelly, & Wallace, 2012), because women are concentrated in jobs that are less prestigious and less well-paying. Occupational gender segregation is also economically inefficient, as it may discourage talented individuals from entering gender-atypical occupations where they would perform well (Hegewisch, Liepmann, Hayes, & Hartmann, 2010). Indeed, young people's career preferences and perceptions of career opportunities and success are strongly affected by the extent to which their own gender is represented in that career (e.g., Miller & Budd, 1999; Reskin & Hartmann, 1986; Tinklin, Croxford, Ducklin, & Frame, 2005), and by the apparent success of people of their gender in that career (e.g., Correll, 2004; Lockwood, 2006), making occupational gender segregation self-perpetuating.

☆ The research was conducted at FIU. The opinions expressed do not necessarily represent the views and opinions of ACT, Inc.

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The reasons proposed for occupational gender segregation include that women and men may selectively choose their occupations, they may be directed toward different occupations, they may be hired for different occupations, and they may leave particular occupations at differing rates. Supply-side and demand-side theories focus on different reasons for workplace segregation. Supply-side theories focus on the role that workers' values, skills, choices, and interests play in segregation, while demand-side theories focus on the influence of social and structural forces, like job, workplace, and cultural features and practices (Okamoto & England, 1999). Research suggests it is likely that both internal and external forces operate simultaneously to affect work segregation (e.g., McDowell, Cunningham, & Singer, 2009), with differing contributions depending on the context and phenomena under investigation (e.g., Wood & Eagly, 2002).

1.1. Supply and demand

In terms of demand-side explanations, gender stereotypes can prevent women from being hired and promoted into particular occupational roles (e.g., Biblarz, Bengston, & Bucur, 1996; Eagly & Karau, 2002; Heilman, Wallen, Fuchs, & Tamkins, 2004). Women may also deliberately choose or retain jobs that permit them more flexibility (e.g., Carlson et al., 2011; Gabriel & Schmitz, 2007; Goldberg Dey & Hill, 2007), perhaps on account of gender role socialization that accords them a greater burden of child care and domestic work (e.g., Bianchi, Robinson, & Milkie, 2006; Friedman & Marshall, 2004; Saxbe, Repetti, & Graesch, 2011). Research has also found that gender stereotypes about occupations predict the actual distribution of men and women into occupations, suggesting that occupational stereotypes may create gender segregation and vice versa (Cejka & Eagly, 1999).

On the other hand, supply-side theorists have proposed that the sexes have some fundamental and reliable psychological differences that may lead them to different careers, including differing personality, interest, and ability profiles (e.g., Browne, 2006). In terms of personality, Del Giudice, Booth, and Irwing (2012) recently challenged the idea that gender differences in personality are small, finding large differences in U.S. men's and women's personalities. And work by Woods and Hampson (2010) found that children's levels of Openness/Intellect predicted whether or not they entered gender-stereotypic occupations as adults (though males and females with similar levels of this trait ultimately entered different occupations).

In terms of interests, women and men across cultures have been found to express stable and markedly different vocational preferences, with women often preferring to work with people and men often preferring to work with things (e.g., gadgets and mechanisms) (e.g., Harmon & Borgen, 1995; Prediger, 1982; Lippa, 1998; Su, Rounds, & Armstrong, 2009). Gender differences in vocational interests have been found to account for an economically and statistically large fraction of the occupational gender gap in information technology (Rosenbloom, Ash, Dupont, & Coder, 2008). It has also been suggested that occupational gender segregation may result from men's relatively homogenous work preferences, goals, and values, and women's more heterogenous work preferences, goals, and values (e.g., Hakim, 2000, 2005, 2006; Morgan, Isaac, & Sansone, 2001). These differential preferences and goals, however, may derive in part from the family structure and gender roles, again illustrating the reciprocal relationship between supply and demand-side factors.

Finally, in terms of abilities, much research finds that males and females are highly similar in cognitive ability and performance (Hyde, 2005; Spelke, 2005). The differences that do exist are typically small and not always in line with gender stereotypes (e.g., Lindberg, Hyde, Petersen, & Linn, 2010; Voyer & Voyer, 2014). There are exceptions, however, such as gender differences in mental rotation performance (Voyer, Voyer, & Bryden, 1995). Some research also shows that women's abilities are more symmetrical than men's, with math and verbal ability levels tending to coincide (for a review, see Valla & Ceci, 2014), which may provide them a greater array of career choices and contribute to gender work segregation. Specifically, one longitudinal study found that women were more likely than men to have high verbal as well as high math skills, and individuals with this ability profile were less likely to pursue STEM careers than those with high math but moderate verbal skills (Wang, Eccles, & Kenny, 2013).

While it may appear that there is an abundance of literature on internal factors that help to account for gender work segregation, most work has focused on social and structural forces that affect men's and women's work choices and success (for reviews see Eagly & Carli, 2007; Rudman & Glick, 2008). Supply-side explanations for gender segregation have not received as much attention. In fact, the paucity of supply-side explanations for gender work segregation are highlighted in a recent article in one of the premier journals in psychological science which petitioned researchers to take gender differences in interest and ability profiles more seriously in the effort to understand women's underrepresentation in the STEM fields (science, technology, engineering, and math) (Valla & Ceci, 2014). Others have recently argued that, despite their value in predicting work performance and persistence, interest profiles are generally ignored in the employee selection literature and deserve more attention (Nye, Su, Rounds, & Drasgow, 2012).

The relative dearth of supply-side investigations may be partly due to the belief that purely structural explanations lend themselves more easily to solutions than explanations that invoke intrapersonal variables. However, individual difference variables, even those that appear or originate in biological systems (e.g., Maguire, Woollett, & Spiers, 2006), have bidirectional relationships with structural, social, and contextual variables. Therefore, understanding both pieces of the puzzle (and how they interrelate) is critical to developing lasting solutions that promote gender equality in work opportunities and outcomes.

In the current paper, we aim to answer the call to further examine supply-side explanations for work segregation by testing the extent to which the cognitive styles of empathizing and systemizing (Baron-Cohen, 2003) account for occupational gender segregation in the U.S. In doing so, we hope to add to a more complete understanding of the many forces that produce and sustain gender segregation and inequality in the workplace.

1.2. Empathizing and systemizing

Empathizing–Systemizing (E–S) theory proposes that individuals are predisposed toward some combination of the cognitive styles of empathizing and systemizing (Baron-Cohen, 2003), constructs that are independent from general intelligence (Wakabayashi et al., 2006). The tendency toward empathizing has been described as "spontaneously and naturally tuning into the other person's thoughts and feelings" (Baron-Cohen, 2003, p. 21), while the tendency toward systemizing is "the drive to understand a system and to build one" (Baron-Cohen, 2003, p. 61). Thus, empathizing is a drive to identify another person's mental state (i.e., emotions and thoughts) and to respond appropriately to it. It encourages identification with others and allows for substantive communication and for the prediction of others' feelings, thoughts, and behaviors. Systemizing, on the other hand, is a drive to construct and understand rule-based systems such as numerical, abstract, mechanical, motor, or social systems that transform inputs into outputs. Identifying the rules governing these types of systems also allows for prediction and control of these systems (for review see Baron-Cohen, 2009). Those with an exceptionally strong drive toward systemizing tend

to approach problem solving by appealing to mechanisms that do not involve intentions or agency (Fields, 2011).

Much of the discussion about empathizing and systemizing is related to autism (e.g., Baron-Cohen, 2002), but the constructs have been validated and used to understand cognitive and performance differences among typically developing children, adolescents, and adults (e.g., Auyeung, Allison, Wheelwright, & Baron-Cohen, 2012; Park et al., 2012; Wakabayashi et al., 2006; Wakabayashi, Sasaki, & Ogawa, 2012). As pertains to the current investigation, there is now much research using E–S theory to explain gender differences in typical adult's cognitive functioning and performance. E–S theory specifically hypothesizes that, in typical populations, females tend to score higher on empathizing than males and that males tend to score higher on systemizing than females, and these differences can help to account for gender differences in certain cognitive tasks, as well as in psychological preferences and performance.

In line with E–S theory, research has found that women tend to have higher scores on empathizing and men tend to have higher scores on systemizing (Baron-Cohen & Wheelwright, 2004; Cook & Saucier, 2010; Goldenfeld, Baron-Cohen, & Wheelwright, 2006; Voracek & Dressler, 2006). Research has also found that non-heterosexual women have higher systemizing scores than heterosexual women (Nettle, 2007), and that gender differences in EQ and SQ exist across multiple cultures (e.g., Wakabayashi et al., 2007). However, both men and women exhibit the full range of tendencies toward systemizing or empathizing (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003; Goldenfeld et al., 2006; Nettle, 2007), and there is much overlap between the distributions for women and men (Wright & Skagerberg, 2012, who found if a man and a women are chosen randomly, there is a two-thirds chance the man has the higher systemizing score and a two-thirds chance the woman has the higher empathizing score).

E–S research has further found that gender differences in empathizing and systemizing help to account for gender differences in adult's gaze-cuing (Alwall, Johansson, & Hansen, 2010), interest in technology (Nettle, 2007), and mental rotation performance (Cook & Saucier, 2010). One of the more robust gender differences that EQ and SQ help to account for are differences in individuals' interests and fields of study. Nettle (2007) found that SQ is a strong predictor of interest in technology and science both for men and for women, and Billington, Baron-Cohen, and Wheelwright (2007) found that men's and women's choice of university degree (physical sciences versus humanities) is predicted by their SQ scores. Systemizing scores are also predictive of boys' and girls' motivation to study science in multiple countries, including Turkey, Switzerland, Malaysia, and Slovenia (Zeyer et al., 2013), and accounted for student gender differences in motivation to learn science.

For EQ, Valla et al. (2010) found a strong relationship between empathizing difficulties and college men's field of study, with men low in empathizing being especially likely to choose a scientific field of study (e.g., computer science, math, systems science). Austin (2005) and Baron-Cohen, Wheelwright, Skinner, Martin, and Clubley (2001) also found that individuals in the physical sciences had lower scores on measures of social functioning and empathizing than individuals in social sciences or in humanities.

Because EQ and SQ have been found to help account for differences in male's and female's fields of study, we viewed it as an excellent supply-side candidate to help account for occupational gender segregation. It also has the potential to speak to the fact that the most persistent occupational gender segregation appears to be in the STEM, mechanical, and construction fields. While women's representation in high-status jobs has improved over the last 60 years, their representation in "things-oriented" (versus "people-oriented") jobs, or jobs that attract and encourage systemizing, has persisted (Lippa et al., 2014). At all levels, women continue to be found much more in people-oriented occupations than in things-oriented occupations.

Importantly, examining the role that EQ and SQ may play in occupational gender segregation also represents an important advance over examining vocational interests (e.g., Morgan et al., 2001; Rosenbloom et al., 2008), preferences for "people" or "things" (e.g., Lippa, 1998), or occupational plans (e.g., Morgan, Gelbgiser, & Weeden, 2013). This is because empathizing and systemizing are higher-order, biologically-rooted, fundamental cognitive styles (e.g., Lai et al., 2012) that represent part of the basis from which work preferences and interests derive. These dimensions offer explanatory power not only for gender differences in vocational interests, but other types of proclivities that may indirectly but significantly relate to occupational choice and persistence, like tendencies toward certain pastimes, and the ability to empathize with others.

Moreover, EQ and SQ are hypothesized to be quite stable over time (Baron-Cohen, 2003), whereas gender differences in vocational interests appear to be very sensitive to contextual, social, cultural, and economic forces (e.g., Bubany & Hansen, 2011; Ott-Holland, Huang, Ryan, Elizondo, & Wadlington, 2013; Proyer & Häusler, 2007). While vocational interests may change over time and with experience, an individual's proclivity toward empathizing or systemizing should largely persevere, helping to explain job entry as well as persistence. For these reasons, findings relating EQ and SQ to gender work segregation have a high level of theoretical and practical value.

There are two sets of hypotheses for the current study. The first set tests whether occupations which have particular gender segregations have corresponding values for empathizing and systemizing. We expected that women would be concentrated in occupations with higher EQ scores and men would be concentrated in occupations with higher SQ scores.

H1. The proportion of women in an occupation will be positively associated with the mean EQ score for that occupation.

H2. The proportion of men in an occupation will be positively associated with the mean SQ score for that occupation.

These hypotheses are at the occupation level. They are about characteristics of the occupation types rather than the individual employees. It is important not to make inferences about individual behavior from these aggregated occupation level statistics. Robinson (1950) coined the phrase "ecological fallacy" to describe errantly concluding aspects of individual behavior from aggregate data.

The second set of hypotheses examines whether individuals' EQ and SQ scores mediate the gender segregation in occupation choice. That is, we sought to examine if men's and women's EQ and SQ scores accounted for some of the variance in their distributions into each occupation. To examine mediation we first show that there are gender differences on EQ and SQ, and show that there are gender differences in the proportions within several of the occupation types. For occupations that have gender segregation, we hypothesize that part of this association can be accounted for by EQ and SQ scores.

H3. Individuals' EQ and SQ scores will at least partially mediate the relationship between gender and the proportion of men and women in each occupation, for those occupations that show gender segregation.

Finally, it is important to note that our hypotheses will examine the relationship between the numerical dominance of men and women in occupations in our sample rather than the normative dominance of men and women in occupations in the U.S. (Gruber, 1998; Welsh, 1999). That is, we will test how SQ and EQ predict men's and women's distributions into occupation types in a sample of adults rather than examining the extent to which these

variables predict being in occupations are typically dominated by one gender, or the extent to which occupations are stereotyped as masculine or feminine. However, the question that we hope to address with this research is the nature of occupational gender segregation in the country at large. Therefore, we compare the proportions of men and women in occupations in our sample with the proportions of men and women in occupations in the U.S. at large, with the expectation that the distributions of men and women into occupations in our sample will mirror, and therefore be able to speak to, occupational gender distributions nationally.

2. Methods

2.1. Participants

Participants were sampled online by Qualtrics (2012) from their database of over four million volunteers. They were told the survey was a voluntary and confidential psychology study. In total, there were 5186 respondents (59% women; median age bracket 45–54 years of age).

2.2. Materials and procedure

An online survey was conducted to explore gender differences in empathizing and systemizing and to compare response latencies and reliabilities for items. The report on these psychometric aspects of the survey appears in Wright and Skagerberg (2012). Surveys were administered through Qualtrics' survey software and completed by participants during July–August 2011. Qualtrics contacts people in their panel regularly about taking part in surveys in return for a small renumeration for the total number of surveys in which the person takes part. Once the sample has reached the specified number who have completed the survey, the survey is closed. There are advantages and disadvantages of online versus face-to-face and telephone surveys. The sampling tends to be more biased for online non-probability surveys than face-to-face and telephone probability surveys, but there tends to be less measurement error and fewer response biases for online surveys than with these other survey modes (e.g., Yeager et al., 2011).

2.2.1. EQ and SQ measures

Baron-Cohen and colleagues have produced scales for measuring empathizing (EQ for Empathizing Quotient; Baron-Cohen & Wheelwright, 2004) and systemizing (SQ for Systemizing Quotient; Baron-Cohen et al., 2003). Psychometric properties of these scales are reported in Allison, Baron-Cohen, Wheelwright, Stone, and Muncer (2011) for the EQ, and are reported in Ling, Burton, Salt, and Muncer (2009) for the SQ.

The short versions of these scales were used (available at Autism Research Center, 2014). The two forms were used which differed in whether some negatively worded linguistically complex statements from the original versions were made into linguistically simpler positive statements. Participants were assigned one of the two forms at random using the random allocating function which is part of the Qualtrics software.

Both the EQ and the SQ ask people to respond whether they "strongly agree," "slightly agree," "slightly disagree," or "strongly disagree" with statements. Scores were recorded as 1–4 with high scores corresponding to either high empathizing or high systemizing, and the means of these were calculated. Example items are "I can easily tell if someone else wants to enter a conversation," "I can pick up quickly if someone says one thing but means another," "If I had a collection (e.g., CDs, coins, stamps), it would be highly organized" and "When I learn a language, I become intrigued by its grammatical rules." Agreement with the first two items indicates a high level of EQ, while agreement with the last two items indicates high SQ.

The reliabilities of these scales for the employed sample were: Cronbach's $\alpha = .87$ for the original EQ and $\alpha = .87$ for the positively-phrased EQ, and Cronbach's $\alpha = .92$ for the original SQ and $\alpha = .94$ for the positively-phrased SQ. The main differences observed between the original and positively phrased forms were that the positively phrased items were answered more quickly than the negatively phrased questions (Wright & Skagerberg, 2012). Responses on these forms are combined for analysis moving forward.

Table 1
The number of people in each occupation type, the proportion who are women, and whether this differs from the rest of the employed sample.

	n	Prop. women in sample	Prop. women in U.S.[a]	Test of association[b]
Male-dominated				
Mining	3	.00	.13	
Wholesale trade	27	.11	.29	$\chi^2(1) = 20.10$, OR = 10.23, $p < .001$
Construction	57	.19	.09	$\chi^2(1) = 29.69$, OR = 5.44, $p < .001$
Transportation or warehousing	68	.21	.23	$\chi^2(1) = 33.34$, OR = 5.05, $p < .001$
Manufacturing	98	.31	.29	$\chi^2(1) = 24.84$, OR = 2.97, $p < .001$
Management of companies/enterprises	42	.31	.41	$\chi^2(1) = 9.51$, OR = 2.85, $p = .002$
Professional, scientific, or tech services	192	.38	.41	$\chi^2(1) = 25.50$, OR = 2.19, $p < .001$
Real estate or rental/leasing	28	.39	.47	$\chi^2(1) = 2.41$, OR = 1.95, $p = .12$
Neutral				
Forestry, fishing, hunting, or agriculture support	17	.41	.26	$\chi^2(1) = 0.91$, OR = 1.79, $p = .34$
Utilities	18	.44	.23	$\chi^2(1) = 0.51$, OR = 1.57, $p = .47$
Information	54	.46	.38	$\chi^2(1) = 1.56$, OR = 1.46, $p = .21$
Finance	104	.48	.56	$\chi^2(1) = 2.17$, OR = 1.37, $p = .14$
Arts, entertainment, or recreation	72	.54	.46	$\chi^2(1) = 0.01$, OR = 1.06, $p = .90$
Unclassified establishments	154	.57		$\chi^2(1) = 0.11$, OR = 1.07, $p = .74$
Retail trade	236	.59	.48	$\chi^2(1) = 1.05$, OR = 1.20, $p = .31$
Other services	361	.59	.52	$\chi^2(1) = 2.25$, OR = 1.20, $p = .13$
Female-dominated				
Accommodation or food services	79	.68	.59	$\chi^2(1) = 4.91$, OR = 1.76, $p = .03$
Admin, support, waste management, or remediation	44	.70	.40	$\chi^2(1) = 3.44$, OR = 1.93, $p = .06$
Educational services	256	.74	.68	$\chi^2(1) = 38.44$, OR = 2.49, $p < .001$
Health care or social assistance	239	.82	.78	$\chi^2(1) = 72.61$, OR = 4.04, $p < .001$

[a] Numbers are from the U.S. Bureau of Labor Statistics (2012).
[b] The tests are 2×2 χ^2 test, with Yates' correction, for gender with the industry listed versus all others in this list. It is not whether the proportion is different from 50% women, but whether it is different from the 56% women of the employed sample. No statistics are reported for Mining because of the number in that occupation (it is the only condition with expected cell frequency less than 5).

2.2.2. Employment measure

Participants were asked if they were currently employed (yes/no). Forty-three percent, or $n = 2153$, said they were employed and were then asked about their employment occupation. The question asking about employment and the corresponding occupation categories came from the Qualtrics library of questions and was based on the NAICS U.S. Census Bureau codes (U.S. Census Bureau, 2012). Employed participants were asked to select one of the 20 occupation categories, shown in Table 1. Four respondents did not select any of the options, leaving a sample of 2149 for analyses.

The R code and edited output are printed here in `Courier`. They are also available as supplementary material as a .Rnw file. This file includes both the statistical code, in R, and word processing, in LaTeX, and can be executed to produce a pdf (Xie, 2014). Here the data are accessed, some packages accessed, the table created using "xtable" (Dahl, 2013). Information from the tables created for the supplementary materials document is then used to construct the tables in the appropriate journal format.

```
eaton <- read.csv(file.choose())
attach(eaton)
library(mediation); library(xtable)
library(sandwich); library(boot)
library(plotrix); library(xtable)
suppressPackageStartupMessages(library(car,
  warn.conflicts=FALSE,quietly=TRUE))
```

Table 1 is made with the following code.

```
propfemale <- tapply(female,job,mean,na.rm=TRUE)
EQjob <- tapply(EQ,job,mean,na.rm=TRUE)
SQjob <- tapply(SQ,job,mean,na.rm=TRUE)
# 12 mining, 13 unclassified, 18 other
# Using all the jobs for this table
nnames <- names(propfemale)
c1 <- table(job)
c2 <- propfemale
c3 <- rep(NA,length(propfemale))
c4 <- rep(NA,length(propfemale))
c5 <- rep(NA,length(propfemale))
counter <- 0
for (i in nnames){
  counter <- counter+1
  thisjob <- recode(job,'i = 1; NA=NA; else=0')
  if (min(table(thisjob)) < 5) next
  c3[counter] <- chisq.test(thisjob,female)
  $statistic
  c5[counter] <- chisq.test(thisjob,female)
  $p.value
  tt <- table(thisjob,female)
  OR <- (tt[1,1]*tt[2,2]/(tt[1,2]*tt[2,1]))
  if (OR < 1) OR <- 1/OR
  c4[counter] <- OR}
tabx <- cbind(c1,c2,c3,c4,c5)
rownames(tabx) <- nnames
tabl <- tabx[order(c2),]
tabl <- rbind(tabl,c(length(female),mean
  (female),NA,NA,NA))
colnames(tabl) <-
  c('n','prop','chisq(1)','OR','ASL')
rownames(tabl)[dim(tabl)[1]] <- 'Total'
xtable(tabl,caption='The number of people in an
  occupation type, the proportion of people who are
  women, and whether this differs from the rest of
  the employed sample.',label='tab:proptable')
```

Overall, 56.6% were female (found with `mean(female,na.rm=TRUE)`) and median age bracket was 45–54 years (found with `median(age,na.rm=TRUE)`). The sampling procedure used was designed to achieve a diverse sample, but as noted above, online studies have well-known sampling biases including that all respondents have access to the internet and regularly use it, and for the current study that they volunteered to be part of the Qualtrics panel.

3. Results

3.1. Aggregate analyses

Table 1 shows the proportion of women who reported being employed in each occupation type. There are different ways to classify an occupation as having gender segregation or not (e.g., Blau, Ferber, & Winkler, 2010; Kmec, 2005). The occupation types in Table 1 are grouped according to whether the occupation was 60% or more men in our sample ("male-dominated"), 60% or more women in our sample ("female-dominated"), or neither ("neutral"). The variation in these proportions shows that there is occupational gender segregation within the sample. Eight occupations were predominantly comprised of men ("Construction," "Management of companies or enterprises," "Manufacturing," "Mining," "Professional, scientific, or technical services," "Real estate or rental and leasing," "Transportation or warehousing," and "Wholesale trade"), four occupations were predominantly comprised of women ("Accommodation or food services," "Admin, support, waste management, or remediation," "Educational services," and "Health care or social assistance"), and the remaining eight occupations were not dominated by either gender in the current sample.

The occupations dominated by one gender in our sample were also dominated by one gender in the U.S. at large as of 2012 (U.S. Bureau of Labor, 2012). Specifically, the 2012 U.S. Current Population Survey also found that the eight occupations of Construction, Management, Manufacturing, Mining, Professional, scientific, or technical services, Real estate or rental and leasing, Transportation or warehousing, and Wholesale trade to be male dominated at a level of approximately 60% or more, while three of our four female-dominated occupations, Accommodation, Education, and Health Care were female dominated at a level of approximately 60% or more.[1] The figures from the U.S. Bureau of Labor Statistics are included in Table 1 along with the proportions for our sample.

In our sample, only three respondents stated that their occupation was "Mining," and all three were men. Because of the small number the data from this occupation are not considered further. Because the categories "Other services" and "Unclassified establishments" likely include a wide variety of diverse occupations, they are also not considered. We focus on the remaining 17 occupation types.

Scores on EQ and SQ varied significantly by participant gender. For the EQ, the mean response on the 1–4 scale for men overall was 2.93 and for women was 3.10, $t(2147) = 13.16$, $p < .001$. The pooled standard deviation is .31 so the effect in standard deviations is $d = .55$. For the SQ, the mean response for men was 2.80 and for women was 2.60, $t(2147) = 11.87$, $p < .001$, with a pooled standard deviation of .39 and a standardized effect size of $d = .50$. This information was taken from the results of t-tests from R:

```
t.test(EQ~female,var.equal=TRUE)
t.test(SQ~female,var.equal=TRUE)
```

[1] The occupation of "Admin, support, waste management, or remediation" was female-dominated in our sample but not in the U.S. at large according to the 2012 U.S. Bureau of Labor Statistics. We did not ultimately use this occupation in testing our mediational hypotheses because the association between gender and this occupation type in our sample was not strong enough, as will be discussed later.

To test H1 and H2, that the proportion of women in an occupation will be positively associated with that occupation's mean EQ score and that the proportion of men in an occupation will be positively associated that occupation's mean SQ score, we plot the group means of EQ and SQ by the proportion of women in that occupation type in Fig. 1 (three points are labeled because they are discussed in the next section) and test whether the associations are statistically significant. The relationship for EQ is $r = .33$, $df = 15$, $p = .19$, a non-significant association. While this is in the predicted direction of H1, there is not sufficient evidence to support the hypothesis. The relationship for SQ is $r = -.78$, $df = 15$, $p < .001$. Thus, at the group level there is a large negative association between mean SQ and proportion of women, supporting H2. The negative correlation means that, as predicted in H2, jobs that tend to have more men also have higher means for systemizing.[2] It is important to stress that these findings are for group means, and should not be used to infer relationships at the individual level (Robinson, 1950). In the next section individual level data are explored.

The correlation statistics were found with:

```
cor.test(EQjob[c(-12,-13,-18)],propfemale[c(-
  12,-13,-18)])
cor.test(SQjob[c(-12,-13,-18)],propfemale[c(-
  12,-13,-18)])
```

and the plot made with:

```
fgr <- 20
tiff('propfigure.tif',width=fgr*420,
  height=fgr*420,
compression="lzw",res=fgr*72)
plot(propfemale[c(-12,-13,-18)],EQjob
  [c(-12,-13,-18)],pch=21,
cex=.7*log(table(jobn[c(-12,-13,-18)])),
ylim=c(2.53,3.2),xlim=c(0,1),cex.axis=1.3,
cex.lab=1.3,las=1,ylab='Mean EQ/SQ scores',
xlab='Proportion female')
abline(lm(EQjob[c(-12,-13,-18)]~propfemale
  [c(-12,-13, -18)]),lwd=1.5)
points(propfemale[c(-12,-13,-18)],SQjob
  [c(-12,-13,-18)],
cex=.7*log(table(jobn[c(-12,-13,-18)])),
pch=21,bg='grey70')
abline(lm(SQjob[c(-12,-13,-18)]~propfemale
  [c(-12,-13, -18)]),lwd=1.5,col='grey60')
axis.break(2,2.55,style='slash')
legend('topleft',legend=c('EQ','SQ'),
  pch=21,pt.bg= c('white','grey70'),cex=1.3)
text(c(.193,.314,.3825),c(2.87,2.88,2.828),
  c('c','m','p'), cex=1.3)
dev.off
```

3.2. Mediation analyses

To test if EQ and SQ scores account for some of the gender differences in occupations (H3), the mediation model depicted in Fig. 2 was estimated for occupations showing gender segregation. Before testing H3 it is worth examining Table 1 to see which occupations were gender segregated. We our limit discussion and analysis to the eight categories where the association in the sample

[2] Although it was not part of our predictions, it is worth noting that SQ and EQ scores did not interact to predict men's and women's distributions into occupations in our sample.

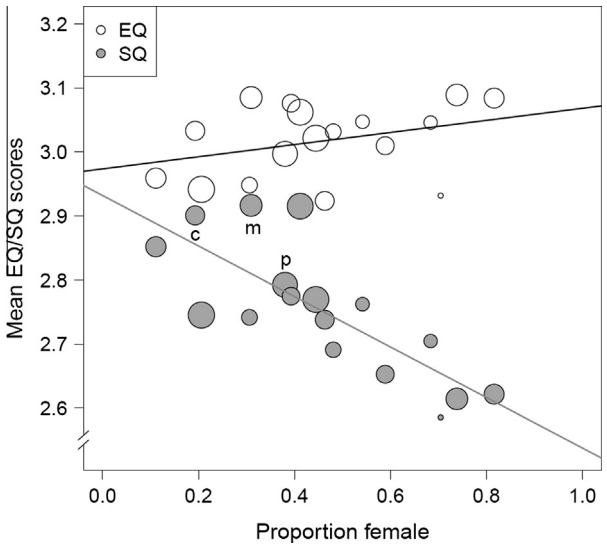

Fig. 1. The mean EQ and SQ scores for each of the occupation types with the proportion of women in that job type. The lines are ordinary least squares regression lines. The area of each circle is proportional to the number of people it represents. The labels correspond to the SQ scores for Construction ("c"), Management ("m"), and Professional/Scientific/Tech ("p").

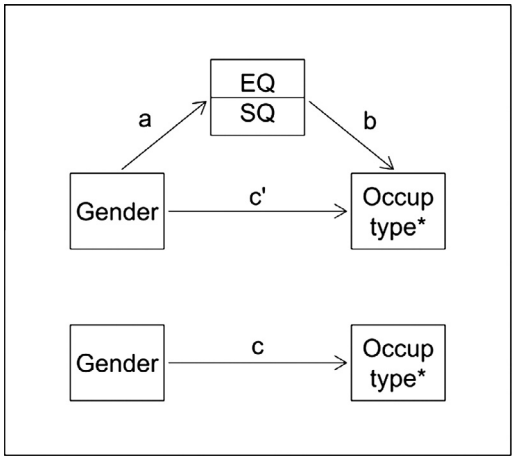

Fig. 2. The model for mediation. The main hypothesis explored is if the mediate path (*ab*) accounts for any of the association between gender and the occupation type. The path *c'* is the direct path, and *c* is the total. Occupation type has a * to denote it is a dummy variable for each occupation.

between gender and occupation type is significant at $p < .01$, which here corresponds to an odds ratio of greater than 2.0. These occupations included five male-dominated occupations and three female-dominated occupations, with percentages ranging from 11% women ("Wholesale trade") to 82% women ("Health"). The odds ratios – which measure the association between gender and occupation type – are also shown in Table 1.

H3 contends that the gender segregation effects will be partially mediated by SQ and EQ. There are different approaches to mediation analysis. MacKinnon (2008) provides a thorough review of the most common type of mediation models. Recently, there has been a move to estimate the average causal mediation effect (ACME). Imai and colleagues (e.g., Imai, Keele, & Tingley, 2010; Imai, Keele, Tingley, & Yamamoto, 2011; Imai, Keele, & Yamamoto, 2010; Imai & Yamamoto, 2013; see also Pearl, forthcoming) argue for this approach and it has been implemented in the package **mediation** (Tingley, Yamamoto, Keele, & Imai, 2013). This approach will be used here.

The following R code estimates the mediated effect, the direct effect, and the proportion of the effect which is mediated by either EQ or SQ. The coefficients for the model for each occupation type for both of these potential mediators are shown in Table 2.

```
tabmediate <- {}
rn <- {}
medEQ <- lm(EQ~female)
medSQ <- lm(SQ~female)
for (i in unique(job)){
  thisjob <- recode(job,'i = 1; NA=NA; else=0')
if (min(table(female,thisjob))<5) next
  if (chisq.test(female,
    thisjob)$p.value > .05) next
  rowvals <- matrix(nrow=2,ncol=12)
  outEQ <-
  glm(thisjob~EQ+female,family=binomial)
  outSQ <-
  glm(thisjob~SQ+female,family=binomial)
mEQ <- suppressWarnings(mediate(medEQ,outEQ,
treat='female',mediator='EQ',robustSE=TRUE,
  sims=1000))
mSQ <- suppressWarnings(mediate(medSQ,outSQ,
treat='female',mediator='SQ',robustSE=TRUE,
  sims=1000))
rowvals[1,1:12] <- c(mEQ$d.avg,mEQ$d.avg.ci,
  mEQ$d.avg.p,
  mEQ$z.avg,mEQ$z.avg.ci,mEQ$z.avg.p,
  mEQ$n.avg,mEQ$n.avg.ci,mEQ$n.avg.p)
rowvals[2,1:12] <- c(mSQ$d.avg,mSQ$d.avg.ci,
  mSQ$d.avg.p,
mSQ$z.avg,mSQ$z.avg.ci,mSQ$z.avg.p,
mSQ$n.avg,mSQ$n.avg.ci,mSQ$n.avg.p)
rn <- c(rn,paste0(i,'EQ'),paste0(i,'SQ'))
tabmediate <- rbind(tabmediate,rowvals)
}
colnames(tabmediate) <- c('mest','mlb','mub','mp',
'dest','dlb','dub','dp','pest','plb','pub','pp')
rownames(tabmediate) <- rn
xtable(tabmediate,label='tab:mediate',digits=4,
  caption='The estimates, CIs, and $p$-values from
  mediate. Note: The first letter in the columns are
  for m=mediation, d=direct, and p=proportion. The
  letters after that are for estimate, lower and
  upper bound, and for non-adjusted $p$-value. mp
  and pp are therefore the same.')
```

EQ and SQ were tested in separate models for each of the eight occupation types. Because of the large number of tests, it is important to be cautious when interpreting effects with p values near to traditional .05 acceptance level. Gender distribution in three of the five male-dominated occupations (Professional/Scientific/Tech, Management, and Construction) was mediated by SQ, EQ, or both. For the Professional/Scientific/Tech category, SQ was a significant mediator of the gender distribution, with higher SQ levels being associated with fewer women in that category, and with approximately 13% of the gender difference being mediated by SQ. For Management and Construction, both EQ and SQ were significant mediators, with increases in SQ and decreases in EQ being associated with a smaller proportion of women in those occupations. For Management, SQ mediation accounted for 23% of the effect of gender and EQ mediation accounted for 22% of the effect. For Construction, SQ mediation accounted for 13% of the gender distribution and EQ mediation accounted for about 10%.

Table 2
The estimates for the mediated effect, the direct effect, and the proportion of the overall effect that is mediated by EQ or SQ.

	Mediated		Direct		Proportion	
	est.	p	est.	p	est.	p
Male-dominated						
Construction						
EQ	.004	.042	−.043	<.001	−.096	.042
SQ	−.005	.002	−.034	<.001	.127	.002
Management						
EQ	.004	.024	−.024	<.001	−.224	.026
SQ	−.005	<.001	−.015	.012	.231	.002
Manufacturing						
EQ	−.003	.264	−.043	<.001	.062	.254
SQ	−.000	.944	−.046	<.001	.004	.944
Prof. Sci. Tech						
EQ	.001	.782	−.064	<.001	.015	.782
SQ	−.008	.010	−.055	<.001	.129	.010
Transport						
EQ	−.001	.558	−.044	<.001	.029	.558
SQ	.001	.784	−.046	<.001	−.013	.784
Female-dominated						
Education						
EQ	.008	.050	.080	<.001	.087	.050
SQ	.007	.048	.082	<.001	.074	.048
Health						
EQ	.003	.362	.114	<.001	.029	.362
SQ	.003	.408	.115	<.001	.025	.408
Accommodation						
EQ	.000	.972	.019	.014	−.003	.976
SQ	−.002	.322	.021	.020	−.101	.332

Among the female-dominated occupations, mediation by SQ, EQ, or both was detected in only one of the three categories: Education. In the category of Education, EQ and SQ just reached statistical significance with approximately 9% and 7% of the effect mediated, respectively. For all of these occupations, the effects are only partial mediation because the direct effect is still significant. While not part of any of the original hypotheses, no evidence was found for interactions between EQ and SQ mediating the gender segregation effect.

In sum, four of the eight occupations with gender segregation showed partial mediation by SQ scores and two of those four occupations also showed partial mediation by EQ scores. The proportion of variation accounted from ranged from 7% to 22%. Thus, H3 was partially supported. Systemizing and empathizing did account for some of the gender segregation effect for four of the eight occupation types tested.

4. Discussion

Although men and women each comprise about half of the total U.S. labor force (U.S. Department of Labor, 2010), certain occupations are dominated by men workers while others are occupied mainly by women workers, a phenomenon referred to as "occupational gender segregation." While ample research has uncovered many reliable social and structural reasons for gender differences in work placement and success (e.g., Cejka & Eagly, 1999; Correll, 2004), intra-individual or "supply-side" reasons for occupational segregation have been underexplored by psychologists (Valla & Ceci, 2014). In the present research, we found that occupation types that had higher scores on the individual difference variable of systemizing, the drive to analyze and create systems (e.g., Baron-Cohen, 2009), tended also to be the ones that employed more men than women. Approximately 60% of the variation in

the gender occupation proportions was accounted for by the mean systemizing score. This aggregate effect is large despite that the survey used the broad occupation classifications shown in Table 2. This may have lessened the size of the effect. For example, although the health and education categories are mostly composed of women, certain specializations (e.g., teaching in early-years education versus high school science) may show different patterns.

The effects of systemizing and empathizing at the individual level were analyzed using mediation analysis (MacKinnon, 2008). Scores on the SQ partially mediated the gender differences in the male-dominated areas of Construction, Management, and Professional/Scientific/Tech services, and in the female-dominated area of Education. Empathizing also accounted for some of the gender segregation in the female-dominated occupation of Education and in the male-dominated occupations of Management. While the mediation effects were not large (accounting for between 7% and 22% of the overall effect), and none of the mediation effects come close to full mediation, it is important to note that the percentages are limited because of the reliability of SQ (although $\alpha > .9$) and because the occupation types are quite broad.

These findings suggest that part of the reason why men and women are in various occupations is their tendency toward systemizing and/or empathizing. More specifically, it suggests that part of the reason Professional/Scientific/Tech services are male-dominated is because of men's higher SQ scores, part of the reason Construction and Management are male-dominated is because of men's higher SQ and lower EQ scores, and part of the reason Education is female-dominated is because of women's higher EQ and lower SQ scores. While some of the partial mediation effects were significant, they did not account for all the variation.

Systemizing was more frequently a mediator of gender segregation than empathizing, consistent with previous research finding stronger relationships between SQ scores and individuals' interests and domains of study than between EQ scores and these same variables (e.g., Nettle, 2007; Zeyer et al., 2013). We also found that a higher proportion of male-dominated fields were related to SQ and/or EQ scores than female-dominated fields (i.e., 3/5 or 60% of the male-dominated occupations versus 1/3 or 33% of the female-dominated occupations). This finding is consistent with research by Valla et al. (2010) showing that men may be more likely than women to enter fields based on their EQ and SQ scores (being especially directed into certain occupations on the basis of low EQ scores). It is also consistent with work finding that women may have more occupational choice than men (Wang, Eccles, & Kenny, 2013), and with the fact that "things-oriented" jobs continue to be more segregated by gender than other jobs or job dimensions (Lippa et al., 2014).

One prominent finding from Table 2 is that for many of the occupations EQ and SQ did not even partially mediate the effect at the 5% significance level. It is clear that many occupations are segregated by gender (Table 1), but not largely due employee's predispositions for empathizing and systemizing.

Further research on the relationship between EQ, SQ, and occupational gender segregation should examine moderators of the effect of these psychological variables; EQ and SQ may be more likely to predict the distribution of highly skilled, college-educated, or intelligent men and women into occupations, whereas those lower in skill, education, or aptitude may be directed into jobs more of the basis of family history, availability, convenience, and other factors unrelated to SQ and EQ.

Returning to the fact that occupational gender segregation has several negative economic and social consequences, our research suggests some strategies for increasing the presence of men and women in gender-atypical occupations. In the case that SQ or EQ scores are part of the reason for men's and women's distributions into occupations, companies within those occupations might attract and retain more of the underrepresented gender by emphasizing and valuing the use of both rule-based reasoning and social and emotional intelligence on the job. For example, in Professional/Scientific/Tech services, where men outnumber women partly as a function of their higher SQ scores, the importance of considering human factors in technological design could be stressed to potential and existing employees to attract and retain more women, as well as men who are high in SQ. Using a larger pool of human talent should result in system designs that consider the psychological experience and desires of the consumer and lead to products and innovations that are functional, user-friendly, and that fulfill important human needs.

Some occupations may necessarily require a high level of systemizing or empathizing from most employees, but the demands of individual jobs are typically quite varied, and bringing this to light can generate interest from candidates that possess these varied skills and interests. For example, while the field of Construction may require and foster systems skills, most construction managers, engineers, and trades people work in teams and with clients. These interactions would be unsuccessful without the ability to predict and relate to others. Moreover, there is much variance in the responsibilities and skills required across jobs in any occupation.

Finally, the present research is not without its limitations. The main limitation of these findings is that we cannot make definitive conclusions about why SQ and EQ are related to the proportion of men and women in some occupations. First, it is unclear if SQ and EQ predispose individuals to enter certain occupations or whether SQ and EQ differentially cause individuals to drop out of particular occupations. If SQ and EQ are in fact sex-linked predispositions, it is unlikely that SQ and EQ are the consequence of occupational choice.

Second, while Baron-Cohen (2003) claims that these cognitive styles represent "essential" differences among people (with men tending to be higher in SQ and women in EQ), SQ and EQ scores are typically assigned on the basis of self-reports, which may be biased in favor of gender role norms and occupational norms. And even though there is evidence showing SQ and EQ are associated with distinct neurobiological profiles (e.g., Cheng et al., 2009; Focquaert, Steven-Wheeler, Vanneste, Doron, & Platek, 2010; Lai et al., 2012), socialization practices associated with gender role norms can shape preferences and cognitive and brain structures over time (e.g., Fine, 2010; Jordan-Young, 2010). However, there does appear to be a biological basis for at least EQ, as it is associated with genetic polymorphisms (Chakrabarti et al., 2009) and prenatal testosterone levels (Chapman et al., 2006).

It should also be noted that while the present research examined occupational gender segregation – the distribution of men and women within occupations – vertical segregation within occupations and organizations may be an even more nefarious problem for creating and sustaining gender equality (e.g., Blackburn & Jarman, 2006). Indeed, increasing the proportion of women in male-dominated jobs, for example, may mask job-level segregation that sustains women's economic and social inequality (Reskin & Roos, 1990). Exploring intrapersonal variables that might contribute to this important parallel issue deserves future consideration.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jrp.2014.06.004.

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