The Wages of Sinistrality: Handedness, Brain Structure and Human Capital Accumulation

Joshua Goodman

Abstract

Prior biological research has shown that left- and right-handed individuals have differing brain structures, particularly in relation to language processing. I argue that left-handedness can be considered a proxy for differential neural wiring generated in part by poor infant health. Using five data sets from the US and the UK, I show that low birthweight and complicated labors increase the likelihood of a child being left-handed. Even conditional on observable measures of infant health and family background, lefties exhibit economically and statistically significant human capital deficits relative to righties. Compared to righties, lefties score a tenth of a standard deviation lower on measures of cognitive skill, are more likely to have emotional or behavioral problems, and are more likely to have learning disabilities such as dyslexia. Differences between left- and right-handed siblings are similar or larger in magnitude. Lefties have lower educational attainment and have hourly wages that are six percent lower than righties. Parents and schools could use this easily observable characteristic to identify a subgroup of children whose cognitive and behavioral development may warrant additional attention.

1 Introduction

Economists are increasingly interested in the extent to which cognitive and non-cognitive skills contribute to individuals' labor market success. One well-known line of research (Heckman, 2011) argues for the importance of the early influences on the development of children's brains. Another set of papers stresses the role that mental health and behavioral disorders have on children's later outcomes (Currie and Stabile, 2006; Aizer, 2009). One central challenge facing such papers is the difficulty in objectively distinguishing individuals by actual brain structure. Diagnosis of ADHD is notoriously subjective, as are maternal or teacher reports of child behavior. Furthermore, none of these papers provides direct evidence that fundamental biological differences between children are responsible for the estimated impacts of problems such as ADHD.

I contribute to this literature by exploring handedness as a strong proxy for neural development. Prior biological research has shown that left- and right-handed individuals have differing brain structures, particularly in relation to language processing. I argue that left-handedness can be considered a proxy for differential neural wiring generated in part by poor infant health. Using five data sets from the US and the UK, I show that low birthweight and complicated labors increase the likelihood of a child being left-handed. Even conditional on observable measures of infant health and family background, lefties exhibit economically and statistically significant human capital deficits relative to righties. Compared to righties, lefties score a tenth of a standard deviation lower on measures of cognitive skill, are more likely to have emotional or behavioral problems, and are more likely to have learning disabilities such as dyslexia. Differences between left- and right-handed siblings are similar or larger in magnitude. Lefties have lower educational attainment and have hourly wages that are six percent lower than righties. Parents and schools could use this easily observable characteristic to identify a sub-group of children whose cognitive and behavioral development may warrant additional attention.

2 Handedness

Laterality - the general term for asymmetrical brain functioning that includes handedness, footedness, and eye preference - is present across the animal kingdom. Primates, rodents, birds, fishes, and lizards all display asymmetrical behaviors or brain functions (Bisazza et al., 1998). Roughly 12% of humans are left-handed, with somewhat higher rates among males than females (Vuoksimaa et al., 2009). The prevalence of laterality in humans and other species, as well as its relationship with brain development and other processes, has made laterality a popular topic in the biological and medical literature, though its economic implications have received less attention. Medical and biological research has focused largely on the origins of laterality and descriptive evidence of its effects and related conditions.

2.1 Causes of handedness

Theories about the causes of handedness fall into three categories: social, genetic, and anatomical. The pure social theory argues that hand preference is learned and not biological in origin. A more moderate version of this theory argues that training can overcome natural inclinations. Forced right-handedness has been common throughout history and is still practiced in many parts of the world. In India, for example, a child showing preference for his left hand will have that hand tied behind his back or the left arm broken (Perelle and Ehrman, 2005). Connected to this social theory is the notion of a social evolutionary mechanism. The most popular of these, the "sword and shield" theory, posits that "the soldier who held his shield in his left hand offered his heart better protection and thus had a better chance of survival.... the right hand [thus] grew more skilled in manipulative movement and eventually came to be used for all skilled manipulative activities" (Hardyck and Petrinovich, 1977, p. 388).

Social theories seem incomplete given strong evidence for the genetic and anatomical theories discussed below and given that hand preference has been observed in fetuses in the form of thumb sucking (Vuoksimaa et al., 2009). The genetic theory of handedness is supported by two types of evidence. First, the rate of left-handedness is about 10% for children of two right-handed parents, 20% for children of one left- and one right-handed parent, and about 26% for children of two left-handed parents (McManus and Bryden 1994). Children are also more likely to share handedness with their mother than with their father (Harkins and Michel, 1988). These facts, though suggestive of genetic influence, could also be explained by children learning handedness from their parents, given that most children spend more time in early childhood with their mothers than with their fathers.

The second type of genetic evidence, from twin pairs, is more convincing. One recent study comparing mono- and dizygotic twin pairs estimated that genes account for 24% of the variance in left-handedness (Medland et al., 2008). Genetic factors do not, however, entirely explain handedness, given that 20-25% of monozygotic twins differ in their handedness even though they have identical genomes (Carter-Salzman et al., 1975).

Finally, anatomical theories attribute handedness to the asymmetry of organs. Variations of these theories have been present since Aristotle (Hardyck and Petrinovich, 1977). Modern versions emphasize differentiation of the left and right hemispheres of the brain, which control opposite sides of the body. Because the left hemisphere is generally thought to process language, studies of handedness and brain function focus on linguistic differences between left- and right-handed individuals. Functional magnetic resonance imaging reveals that, when exposed to language, 96% of right-handed individuals show only left hemisphere activity. Just 76% of left-handed individuals show only left hemisphere activity, with the remaining 24% showing activation of either both hemispheres or only the right hemisphere (Pujol et al., 1999). Relatedly, brain lesions on the right hemisphere are more than twice as likely to cause language disorders in the left-handed as in the right-handed (Hardyck and Petrinovich, 1977). This pattern of greater bilateral activation among the left-handed may be related to the corpus callosum, the bundle of neural fibers connecting the two hemispheres, which is 11% larger in the left-handed than the right-handed (Witelson, 1985). This biological evidence makes clear that left-handedness is intimately related to differential brain structure and usage, particularly with respect to language processing.

The cause of this differential brain structure may be partly genetic but one common explanation, known as pathological left-handedness, suggests that stress or trauma during gestation or birth may induce normally left hemispheric functions to shift to the right hemisphere. Left-handedness is more prevalent among infants who required resuscitation after delivery and is more prevalent among twins and triplets than among singleton births. Studies have also found that higher maternal age and lower birthweight are both associated with higher prevalence of left-handedness (Medland et al., 2008; Vuoksimaa et al., 2009). All of these are consistent with the theory that stressors during pregnancy or birth may contribute to the differential brain structures typical of left-handed individuals.

2.2 Handedness and cognitive outcomes

One common argument suggests that the larger corpus callosum and greater bilateral activation exhibited by the left-handed allows for faster connection between ideas and thus more creativity. According to this theory, the left-handed should excel at tasks requiring divergent thinking, where the individual begins from prior knowledge and works outwards toward new concepts, as opposed to convergent thinking, where the individual applies knowledge and rules toward discovering a unique solution to a problem. In a series of experiments, Coren (1995) found that left-handed males performed better on some divergent thinking tasks. The effect was, however, neither consistent across tasks nor significant for left-handed females. The empirical evidence for greater creativity among the left-handed is, it turns out, fairly weak.

Also fairly weak is the evidence that the left-handed are disproportionately represented at the high end of the cognitive spectrum. Evidence purporting to show that left-handed individuals are overrepresented among precocious SAT takers, high-performing MCAT takers, and Mensa Society members all suffer from one or more serious problems such as selection bias, small sample size, or mixed results (Benbow, 1986; Halpern, Haviland and Killian, 1998; Perelle and Ehrman, 2005).

Much clearer is evidence that the left-handed are disproportionately represented at the low end of the cognitive spectrum. The rate of left-handedness among those considered mentally retarded is between 20% and 28%, roughly twice the rate in the general population (Perelle and Ehrman, 2005). Prior work with the NCDS has observed that the left-handed fare worse than the right-handed on tests of overall cognitive ability, even when the lowest performing 5% are excluded (McManus and Mascie-Taylor, 1983). These lower cognitive skills may be at least partly explained by higher rates of learning disabilities like dyslexia among the left- and mixed-handed, as well as higher rates of behavioral problems such as attention-deficit/hyperactivity disorder (Rodriguez et al., 2008). Patients suffering from schizophrenia also display high rates of left-handedness (Dragovic and Hammond, 2005).

2.3 Handedness and human capital accumulation

Despite the ubiquity of handedness in daily life, economists have paid little attention to its effects on human capital accumulation and labor market outcomes. There are two primary reasons to think that handedness might be related to longer-run outcomes of interest to economists. The first is that the preference for one hand over the other may create a comparative advantage or disadvantage in the labor market. Lefties may, for example, be less productive in occupations requiring the use of equipment designed for righties. Conversely, lefties may be more productive in occupations where they benefit from their own relative scarcity. Lefties are, for example, over-represented among top performing athletes in interactive sports such as table tennis, fencing and baseball, though not in non-interactive sports such as gymnastics and bowling (Raymond et al., 1996). This is likely due to the fact that athletes are more frequently trained to compete against right-handed opponents, giving left-handed athletes a comparative advantage. Given how few jobs involve such interactive competition, it is likely that left-handedness is on average a comparative disadvantage, at least in occupations requiring the use of right-handed equipment.

The second reason that handedness may impact longer-run outcomes is that it may be an indicator for differential brain structure. There is ample evidence that the brain structure of lefties differs from that of righties. This expresses itself in the extreme as higher liability of mental retardation and schizophrenia, but the difference also exists for healthy individuals. If the structure of lefties' brains impairs the accumulation of skills, this will surface in labor market outcomes and measures of productivity, and should be apparent early on in cognitive ability. Left-handed individuals might fare poorly in the labor market not due to left-handedness itself, but as a consequence of a related condition. It is easy to see how learning disabilities and cognitive shortcomings could translate into fewer employment opportunities and reduced wages.

Two recent papers using nationally representative samples of children explore the relationship between handedness and early human capital accumulation. In both papers, the authors argue that differences between lefties and righties can not be explained by parental attitudes or investment in children and that differential neural wiring may be the most likely explanation. Using the Longitudinal Study of Australian Children, Johnston, Shah and Shields (2007) find that left-handed children have significantly lower cognitive and noncognitive skills than right-handed children. Using the National Longitudinal Survey of Youth's Children and Young Adult cohorts, Johnston et al. (2010) find similarly significant cognitive gaps between left- and right-handed children. I confirm their results below and extend the analysis to other measures of early human capital.

Two economic studies based on large, nationally representative samples have found mixed results on the relationship between handedness and earnings. Ruebeck, Harrington, and Moffitt (2006), using the National Longitudinal Survey of Youth 1979 cohort, find no statistically significant difference in the wages of lefties and righties, either for men or women. Using the UK's Nation Child Development Study, Denny and O'Sullivan (2007) find that male lefties earn more than male righties but that female lefties earn less than female righties. Both studies suffer, however, from sample selection decisions that render their results difficult to interpret. Both seem to remove from their samples any individuals missing any control variables used in their primary specification, without investigating whether lefties and righties differ in the proportion missing such information. More importantly, both limit the sample to individuals with wages above a certain threshold, either explicitly or implicitly eliminating part-time workers and those not working from consideration. This prevents both studies from exploring the extensive labor force participation margin, which I show below is an important contributor to the overall differences between lefties and righties. I improve on this by defining my samples to include all individuals whose handedness is observed and then showing how robust the wage effects are to different sample definitions.

3 Data and Determinants of Handedness

3.1 Data sets

I use five longitudinal data sets, three from the United States and two from Great Britain. All five contain information on handedness, as well as measures of cognitive skill and other evidence of human capital accumulation.

The American data sets are three cohorts of the National Longitudinal Survey of Youth. The NLSY79 is a nationally representative sample of youth ages 14-22 when first interviewed in 1979. Interviews were conducted annually through 1994 and are now conducted biennially. The NLSY97 is a nationally representative sample of youth ages 12-17 when first interviewed in 1997. Interviews are conducted annually. In the most recent interview waves available, NLSY79 respondents are 43-51 years old and NLSY97 respondents are 24-29 years old.

The third American data set is the NLSY Children and Young Adults (NLSC), which follows all children born to the women in the NLSY79. Interviews of these children have been conducted biennially since 1986. Unlike the other data sets used in this paper, the NLSC interviews multiple siblings from the same family, allowing within-family analysis of the effect of handedness. Longer term outcomes are, however, harder to explore in the NLSC because many of the children followed were born too recently to have completed schooling or entered the labor market. For all three American data sets, I use only the nationally representative cross-sectional samples and omit the minority, economically disadvantaged and military oversamples.

The two British data sets are the National Child Development Study (NCDS58), which follows over time all people born in Great Britain in one week in March 1958, and the British Cohort Study (BCS70), which all people born in Great Britain in one week in April 1970. Both data sets begin at birth and subjects are subsequently interviewed about every five years through the present.

3.2 Measuring handedness

Each of the five data sets asks somewhat different questions regarding handedness. The NLSY79 asked its subjects once in 1993, when they were 28-36 years old: ”Were you born naturally left-handed or right-handed?" The NLSY97 asked its subjects twice in 2001 and 2002, when they were 16-22 years old: "Are you left-handed or right-handed?" Every survey year since 1996, the NLSC has asked three questions of the mothers of 2-14 year-olds: Which hand does the child use when brushing teeth, when throwing a ball, and when writing? Youths older than 14 were directly asked these same questions in 1996 and 1998 and each was also asked, "As a child, were you ever forced to change the hand with which you write?"

The NCDS58 explored handedness at ages 7, 11 and 16. At age 7, each mother was asked to state her child's handedness. Interviewers also recorded which hand each child used to throw a crumpled paper ball and to draw a cross. At age 11, each mother was again asked to state her child's handedness and was then specifically asked which hand her child uses to write. Interviewers also recorded which hand each child used to throw a ball. At age 16, each youth was asked with which hand he or she writes best.

The BCS70 explored handedness at ages 10 and 16. At age 10, interviewers recorded which hand each child used to pick up a ball and to mime combing his or her hair. Each child was also asked which hand he or she uses to write. At age 16, each youth is asked which hand he or she uses to write a letter, throw a ball, hold a racket, hold the top of a broom to sweep, hold the top of a shovel, hold a match when striking it, hold scissors, deal playing cards, hammer a nail and unscrew the lid of a jar.

For each question asked about handedness across all five data sets, I assign a value of 1 to answers that clearly favor the left hand (such as "always left" or "usually left") and a value of 0 to answers that clearly favor the right hand. I assign a value of 0.5 to answers indicating mixed-handedness or a lack of hand preference. To construct a continuous measure of left-handedness, I compute for each year the mean response to handedness questions and then compute the mean of these values across all years. This weights each year equally, regardless of how many handedness questions were asked that year. I exclude from the samples individuals for whom I can not construct any measure of handedness.

The distribution of this continuous measure of handedness is shown for each study in Figure 1. In all of the samples, except for the NLSY97, the distribution of left-handedness is clearly concentrated at the extremes, so that most individuals can be easily categorized as right- or left-handed. The mass in the middle of the NLSY97 distribution is due largely to 341 individuals who claim to be right-handed in one year and left-handed in the other. To construct a binary measure of left-handedness, I round this continuous measure to the nearest integer. This implies that some mixed-handed individuals are categorized as left-handed. I later show that my central results are not sensitive to changes in the definition of left-handedness. Also, in the NLSC, 37 youths report currently preferring their right hand but also report having been forced to switch handedness earlier in life. I categorize these youths as left-handed. For family fixed effects analysis, I then create a subsample of the NLSC called NLSC-FE, which is limited to children from families with at least one left-handed and at least one right-handed child.

3.3 Summary statistics

Table 1 shows the mean values of selected variables from the six samples used in this study. Panel (A) lists the basic controls included in subsequent regressions in the paper. Individuals in the NLSY97 sample range from 25 to 29 years old as of the most recent wave, while the remaining three studies' subjects are all observable through at least their mid-30s. The average individual in the NLSC is 20 years old at the most recent wave in 2008, so that long run outcomes such as college graduation and labor market earnings are not yet observable for the majority of the sample.

In all of the non-fixed-effects samples except the NLSY97, the rate of left-handedness is a remarkably consistent 11% to 13%, well within the range observed in studies of other populations. This suggests that the constructed measure of handedness is fairly accurate. The 16% rate of left-handedness in the NLSY97 is largely due to categorizing the large mass of mixed-handed individuals as left-handed. The rate of left-handedness is substantially higher in the NLSC-FE due to the exclusion of families without left-handed children.

In all of the studies, I observe gender, birth order, and mother's age at birth. I construct a dummy for an individual's mother being highly educated, which for consistency across studies implies being in the top quartile of the education distribution for women. I observe race in the US studies. Various measures of infant health are recorded in the NLSC and the UK studies, including birthweight, whether the child's mother was smoking during pregnancy, and whether there was any indication of infant health challenges around the time of birth.[1] Because the NLSC children can be connected to their mothers in the NLSY79, I can construct a dummy for each child indicating whether his or her mother was left-handed. The NLSC-FE sample is remarkably similar to the full NLSCY sample in terms of nearly all covariates except that the fixed effects sample has a higher proportion of blacks and those with left-handed mothers.

Panel (B) shows selected outcomes, the construction of which will be discussed in more detail below. For all six samples, I observe a measure of cognitive skill that I transform into an age-normed Z-score, as well as an indicator for having behavioral problems. For the samples in which I observe individuals into adulthood, I observe educational attainment and hourly wages as measured in 2009 dollars or pounds sterling. Below panel (B) are listed each sample's size, which refers to the number of individuals for whom handedness is observed. Outcomes are observed for smaller numbers of individuals due to attrition and missing data.

3.4 Determinants of handedness

Table 2 shows the results of linear probability models in which an indicator for left-handedness is regressed on the covariates listed in Table 1. Column (1) uses the full NLSC sample, while column (2) uses the fixed effects subsample. Column (3) pools the US adult samples represented individually in columns (4) and (5), including as a control an indicator for the sample of origin. Similarly, column (6) pools the UK data sets represented individually in columns (7) and (8), also with an indicator for the sample of origin. Subsequent regression tables in the paper have a similar structure.

There is clear evidence that gender and maternal left-handedness are closely associated with children's left-handedness. Across all the samples, women are roughly three percentage points less likely than men to be left-handed. Rates of left-handedness thus range in these samples for females from 9-15% and for males from 12-18%. In column (2), the gender difference is an even

[1] For the NLCS samples, the dummy for birth complications indicates that the child remained in the hospital for more than a week after being born. For the UK samples, it indicates that the birth was a breech birth or that forceps or a vacuum were used during delivery.

greater 15 percentage points because the base rate of left-handedness in males in the fixed effects sample is 42%. Column (1) also reveals that children with left-handed mothers are about five percentage points more likely to be left-handed themselves (about 16% of such children are left-handed). These relationships between gender, maternal handedness and left-handedness are consistent with patterns seen in previous studies on the topic.

Mother's age at birth and mother's education level have little association with left-handedness in these data, though birth order is predictive of handedness in two of the three US samples. Measures of infant health do, however, have fairly consistent associations with handedness. In the UK data sets, lower birthweight babies are more likely to be left-handed, with each additional pound at birth associated with a 0.4 percentage point decrease in the rate of left-handedness. The NLSC birthweight coefficients are also negative but the smaller sample sizes render the estimates more imprecise. In these same samples, complications around the time of birth also increase the rate of left-handedness. US babies that remain more than a week in the hospital post-birth are five percentage points more likely to be left-handed, while UK babies whose labors were complicated are 1.5 percentage points more likely to be left-handed. The coefficient on maternal smoking is positive but statistically insignificant. At the bottom of each column is reported the p-value from an F-test of the three indicators of infant health (birthweight, birth complications, and maternal smoking). In the NLSC sample, the p-value of .118 is close to marginally significant, while these factors are clearly jointly significant in the pooled UK sample.

There is also some evidence that race is associated with left-handedness. In the NLSC, black children are three percentage points more likely to be left-handed than white children, while there is no statistically significant difference between Hispanic and white children. The pooled US data similarly suggest that blacks are two percentage points more likely to be left-handed than whites. One possible explanation for this pattern is that the racial differences observed here may be due to unobserved differences in prenatal care and fetal stresses. In the US, black infants have substantially worse health at birth than do white infants. Given the lack of detailed controls for infant health in these regressions, race may be serving as a proxy for unobserved fetal and infant health measures.

4 Human Capital Accumulation

4.1 Cognitive skills

The main measures of cognitive ability come from math and reading comprehension tests administered in all of the studies. The NLSC administered Peabody Individual Achievement Tests in each wave for each subject between the ages of 5 and 14. The NLSY79 and NLSY97 both administered in a single wave the Armed Services Vocational Aptitude Battery (ASVAB), at ages 17-24 in the NLSY79 and ages 14-19 in the NLSY97. The NCDS58 administered math and reading tests at ages 7, 11, and 16. The BCS70 administered a math test at age 10 and reading comprehension tests at ages 5 and 10. Raw math and reading comprehension scores were normalized by age within each study, averaged across multiple ages for individuals tested more than once, then normalized again within each study. A cognitive ability Z-score was then constructed as the normalized average of the math and reading Z-scores.

Table 3 shows the difference in cognitive skills between lefties and righties conditional on the set of covariates listed in the notes to table 2. In all of the samples except the NLSY79, lefties show statistically significantly lower cognitive skills than righties. In the top row, the coefficients imply that lefties have overall cognitive skills 0.11 standard deviations lower than righties in the NLSC. The point estimate of the gap between left- and right-handed siblings is an even larger 0.16 standard deviations. The NLSY79 is the only one of the samples in which the cognitive difference between lefties and righties, though negative, is too small to be statistically significant. The cognitive gap in the NLSY97 is nearly identical to that in the NLSC, and the gap in the British samples is about 0.06-0.08 standard deviations. The second and third rows of table 3, which analyze math and reading scores separately, show that the cognitive gap between lefties and righties is nearly identical across the two subjects. This suggests that, even if differential language processing is responsible for these cognitive gaps, such differences equally affect both math and reading skills.

One popular claim about lefties is that they are more likely to be highly talented, perhaps because of increased creativity. This claim suggests that aspects of the cognitive skill distribution other than the mean are worth exploring. To do this, I plot in figures 2, 3, and 4 the cumulative distribution functions of cognitive skill for the NLSC, the pooled US sample, and the pooled UK sample. The height of each curve measures the fraction of individuals who fall at or below that point in the cognitive skill distribution. There is no evidence at the upper end of the distribution that the lefties' CDF falls below the righties' CDF, implying no increased likelihood of particularly high ability in lefties. The third and fourth rows of table 3 test this rigorously by running regressions in which the outcomes are indicators for being in the top and bottom 10% of the cognitive skill distribution. Consistent with the plotted CDFs, lefties are 2-4 percentage points more likely to be in the bottom 10% of the distribution and, in all samples but the NCDS58, are 1-2 percentage points less likely to be in the top 10% of the distribution. Tests of the probability of being in the top 5% or 1% of the distribution show similar results. There is no evidence that lefties are more likely to be highly talented, at least by these measures of cognitive skill. Direct measures of creativity are unfortunately absent from these data sets.

Further evidence of cognitive gaps come from tests administered in only some of the studies. In the NLSY79 and NLSY97, part of the ASVAB consisted of a coding speed test in which subjects match words to numbers based on a key. Given that the task requires nearly no prior knowledge and that subjects have only seven minutes to complete as many matches as possible, the test is thought to measure raw mental speed or fluid intelligence (Heckman, 1995; Segal, ????). By this measure, lefties in both samples score roughly a tenth of a standard deviation worse than righties. Though the math and reading scores suggest that the NLSY79 is the only sample in which lefties and righties have similar cognitive skills, the difference in coding speeds suggests that even in that sample there are cognitive differences between the two groups. The British studies also administered a test requiring little prior knowledge. Children ages 4-7 were given the Copying Designs test, in which they were shown images of circles, crosses, and other shapes and asked to copy those designs on a sheet of paper. Lefties scored 0.12 standard deviations worse on this test than righties. Both the coding speed and copying designs results suggest that the observed cognitive gaps are not only about acquired knowledge itself but also about deeper cognitive skills necessary to acquire knowledge.

4.2 Disabilities

Before turning toward long-run measures of human capital, I first explore factors other than cognitive skills that might also affect such long-run outcomes. Given that previous studies have found left-handedness to be associated with a variety of impairments and behavioral problems, I construct measures of a number of such factors. All of the samples except the BCS70 contain a binary measure of whether the subject suffers from an emotional or behavioral problem. Three of the studies also contain continuous measures of behavioral problems reported by a parent, the Behavior Problems Index in the NLSC, the Bristol Social Adjustment Guide in the NCDS58, and the Rutter Scale in the BCS70. I construct an indicator for having a behavior problem that takes a value of one if either the binary measure equals one or if the age-normalized continuous measure falls in the top 5% of the distribution. The first row of table 4 shows strong evidence that lefties are more likely to have behavior problems. The NLSC sample suggests that lefties are 3.4 percentage points more likely to have behavior problems than righties, a difference that grows to 4.8 percentage points when comparing left- and right-handed siblings. Given that roughly 8 percent of righties in the NLSC samples have behavior problems, this implies that lefties are about 50 percent more likely than righties to have such problems. The pooled US and UK samples also show statistically significant differences, with lefties in those samples about 1.5 percentage points more likely to have behavior problems. Though the magnitudes of these differences vary across samples, likely due to different question wording and ages at interviews, the estimates clearly indicate increased behavior problems among lefties.

Previous research has suggested that left-handedness is unusually common among mentally retarded individuals. This fact is cited in support of the theory of pathological left-handedness, the idea that some portion of left-handedness can be thought of as a form of brain damage, perhaps due to fetal trauma. Each of the data sets used in this paper allow construction of an indicator for mental retardation, either through parental reporting, self-reporting, or interviewers' observations of the subject. In all of the samples, a high proportion of the mentally retarded individuals are left-handed. In the most extreme case, seven of the eight mentally retarded children in the NLSC-FE are left-handed. In the other samples, the proportion ranges from 15-33%, all above the population rate of 12%. The second row of table 4 shows that lefties are consistently about one percentage point more likely to be mentally retarded than righties, a difference that is at least marginally statistically significant in all samples except the NLSY79. Given that the rate of mental retardation in righties is under 1 percent in most of the samples, this represents a very large percentage increase, though the absolute number of mentally retarded lefties is quite small. These results confirm the prior findings and add further evidence that brain structure and handedness are closely related.

Given the biological evidence that lefties process language differently than righties, I construct two further measures of disability related to language. The first is an indicator for having a speech problem, such as a stutter or other speech impairment. In both NLSC samples and the British samples, lefties are about 2 percentage points more likely to have such speech problems. The second measure is an indicator for having a learning disability, questions about which often mention dyslexia specifically. In both the NLSC samples and the NLSY97 sample, lefties are 2-3 percentage points more likely to report a learning disability than righties, a proportional increase of roughly 25-50 percent. Finally, the NLSC and BCS administered to children ages 7-11 a digit span test to find the maximum number of digits a subject could memorize and recite forward (in both studies) or backward (in the NLSC only). There is little evidence that lefties are worse at reciting digit lists in the forward direction, which is generally considered a test of short-term auditory memory. Lefties are, however, substantially worse at reciting the digits backwards, which is thought to measure the child's ability to manipulate verbal information in temporary storage.[2] This may be further evidence of an impairment related to dyslexia or other difficulties with language processing.

4.3 Earnings

Long-run earnings outcomes are available for all studies but the NLSC, many of whose subjects are too young to observe such outcomes as of the most recent wave. I construct hourly wages in way that makes the US samples comparable to each other and the UK samples comparable to each other. Because NLSY97 subjects were ages 25-29 at the last wave of interviews, in both

[2]See p. 103 of the June 2009 version of the "'NLSY79 Child Young Adults Data Users Guide"'.

the NLSY79 and NLSY97 I define the hourly wage as the last non-missing wage value observed from ages 25-29. In the British studies, I construct hourly wages at age 33-34 for all respondents reporting earnings, including full-time workers, part-time workers and the self-employed. Unless otherwise noted, the constructed wage distribution includes non-working individuals as having a zero hourly wages. US and UK wages are expressed in 2009 dollars and pounds sterling respectively.

Table 5 shows the wage difference between lefties and righties through a number of different specifications. The first row shows differences in the mean wage. In the pooled US sample, lefties earn on average about $0.84 less per hour than righties, a highly statistically significant difference that is quite similar in magnitude across the two individual samples. Given that righties earn a mean hourly wage of about $14, this implies that lefties earn roughly 6% less than righties. The pooled UK sample suggests that lefties in the UK earn £0.52 less per hour than righties, a highly statistically significant difference that is due largely to the more recent of the two UK samples. Given the mean wage of righties in the pooled sample, this also represents a roughly 6% wage difference.

To check that these gaps are not due to outliers or to miscoding of individuals with unusually low or high wages, I run quantile regressions in the second row of 5 to check the gap in the median wage between lefties and righties. This has little substantialy impact on the estimated gap in any of the individual US and UK samples, suggesting that outliers are not the source of the difference. The third row of table 5 uses as an outcome an indicator for having a wage below three dollars or two pounds per hour. The majority of such individuals have zero hourly wages and are thus not working, so this outcome can be thought of as indicating little or no participation in the labor force. In the US samples, lefties are four percentage points more likely to have low wages, which represents a roughly 50% increase over the eight percentage point rate of low wages among righties. The NCDS shows no difference between lefties and righities in the rate of low wages, but the BCS shows a difference of 5 percentage points, similar in magnitude to the US samples.

The last three rows of table 5 use as outcomes the logarithm of various hourly wage measures. The fourth row uses the logarithm of the hourly wage, thus eliminating zeroes from the sample.

These results suggest that lefties earn six percent less than righties in the US and four percent less than righties in the UK, results similar in magnitude to the first two rows of the table. The fifth row uses the censored wage, for which low wage individuals are assigned a wage of three dollars or two pounds. Under this assumption, individuals for whom reasonable wages are not observed are assumed to have very low earning capacity. This increases the apparent size of the gap between lefties and righties to six to eight percent in the UK and US. The sixth and last row removes all low wage individuals, not just zero wage earners, from the sample. This reduces the gap between lefties and righties to two to three percent, suggesting that roughly half of the gap in earnings is due to lefties' increased likelihood of having low or no wages at all. All of these results suggest that lefties earn less than righties, a result that is robust to different specifications.

To further test the robustness of the estimated gaps in cognitive skills and wages, table 6 considers three further specifications for each outcome. In panel (A), the first row replicates the first row of table 3, which will serve as a baseline. The second row changes the explanatory variable from a binary measure of left-handedness to the continuous measure from which that binary measure was originally constructed, as described previously. This has little impact on the estimte cognitive skill gaps, suggesting that the results are not driven by imposing a binary definition of handedness. The third row uses the binary measure of handedness but eliminates from the sample mixed-handed individuals, those for whom the continuous measure of handedness is between one-third and two-thirds. This has little impact but does slightly shrink the estimated gaps, suggesting that mixed-handers have even lower cognitive skills than do lefties. The sample of mixed-handers is, however, generally too small to be able to investigate in more depth. Finally, the fourth row of the table removes from the sample individuals identified as mentally retarded in order to check whether the gaps are being driven by the extreme version of pathological left-handedness discussed above. This also has little impact on the estimated gaps, largely because the number of such individuals is quite small in these samples. Panel (B) performs the same robustness checks using hourly wages as an outcome and shows that the magnitude and statistical significance of the estimated gaps is not particularly sensitive to any of these choices of specification. The magnitude of the cognitive skill and wage gaps is not sensitive to the precise definition of handedness. Nor are such gapes explained by the pathological left-handedness of mentally retarded individuals.

Long-run education outcomes are available for all studies but the NLSC, many of whose subjects are too young to observe such outcomes as of the most recent wave. For comparability across the American and British data sets, educational attainment is defined by four mutually exclusive categories: being a high school dropout, being a high school graduate, being a college gradute, and missing information about education. In the US samples, I construct these using the maximum level of education reported within ten years of the start of the study, at which point subjects were in their mid-twenties to early thirties. Those reporting at least 12 years of education are considered high school graduates and those reporting at least 16 years are considered college graduates. In the British studies, subjects were asked at age 33-34 for their highest academic qualification. Those with O-levels or higher are considered high school graduates and those with qualifications beyond A-levels are considered college graduates. Table 7 shows that lefties in the US are three percentage points more likely to stop their education after high school and not complete a college degree. The UK results, though not statistically significant, also suggest that lefties are more likely to be high school dropouts than righties. These differences are not due to diffential probability of having such information available in the data. These results are not surprising, given the lower cognitive skills and increased rates of learning disabilities among lefties, both of which likely make it more difficult to complete various levels of educational attainment.

Table 8 explores whether the cognitive skill and wage gaps differ by gender by running the baseline regressions separately for men and women. In panel (A), the cognitive skill gaps are generally quite similar for men and women and for no sample is the difference between the two coefficients statistically significant. In panel (B), the wage gap between lefties and righties is generally large for women than for men, but the sample size again prevents me from rejecting the hypothesis that the two gaps are equal. Given that women are less likely than men to work in occupations with machines that might prove difficult for lefties to use, this suggests that the wage gap between lefties and righties is not explained by the physical disadvantage of being differently handed.

Table 9 explores the extent to which the observed differences between lefties and righties in cognitive skill, disabilities and educational attainment can explain the observe wage gap. The first row replicates the first row of table 5 as a baseline. The second row adds to that separate controls for math and reading skill. The third row adds further controls for mental retardation and emotional/behavior problems. The fourth row adds further controls for educational attainment. In the pooled US sample, the addition of all of these controls reduces the hourly wage gap from $0.83 to $0.55, a reduction of slightly more than a third. In the pooled UK sample, the gap is reduced by slightly less than a quarter. These observed differences in human capital accumulation thus explain a substantial fraction of the wage gap but the majority of the gap remains unexplained. Either these measures do not sufficiently capture each individual's human capital or there are other channels through which handedness may also be operating on wages.

5 Conclusion

Across the multiple samples used in this paper, left-handed individuals show consistently lower cognitive skills, higher rates of mental or behavioral disabilities, lower educational attainment and lower wages than right-handed individuals. I argue that a substantial fraction of the wage gap can be explained by these human capital deficits. As shown in table 10, the magnitude of the left-right gap in cognitive skill is roughly one sixth of the black-white skill gap, while the left-right gap in hourly wages is roughly one third that of the black-white gap. These gaps are thus large enough to be worthy of our attention.

The evidence I present is strongly suggestive that these gaps arise as a result of differential brain structure between lefties and righties, differences that stem in part from fetal health shocks. Regardless of the cause of this gap, handedness presents parents and schools with a measure of brain structure that is almost costless to observe. Given the increased educational challenges associated with being left-handed, parents and schools could thus use handedness to identify potentially challenged students earlier and at less cost than they might otherwise.

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Figure 1: Distribution of Left-Handedness

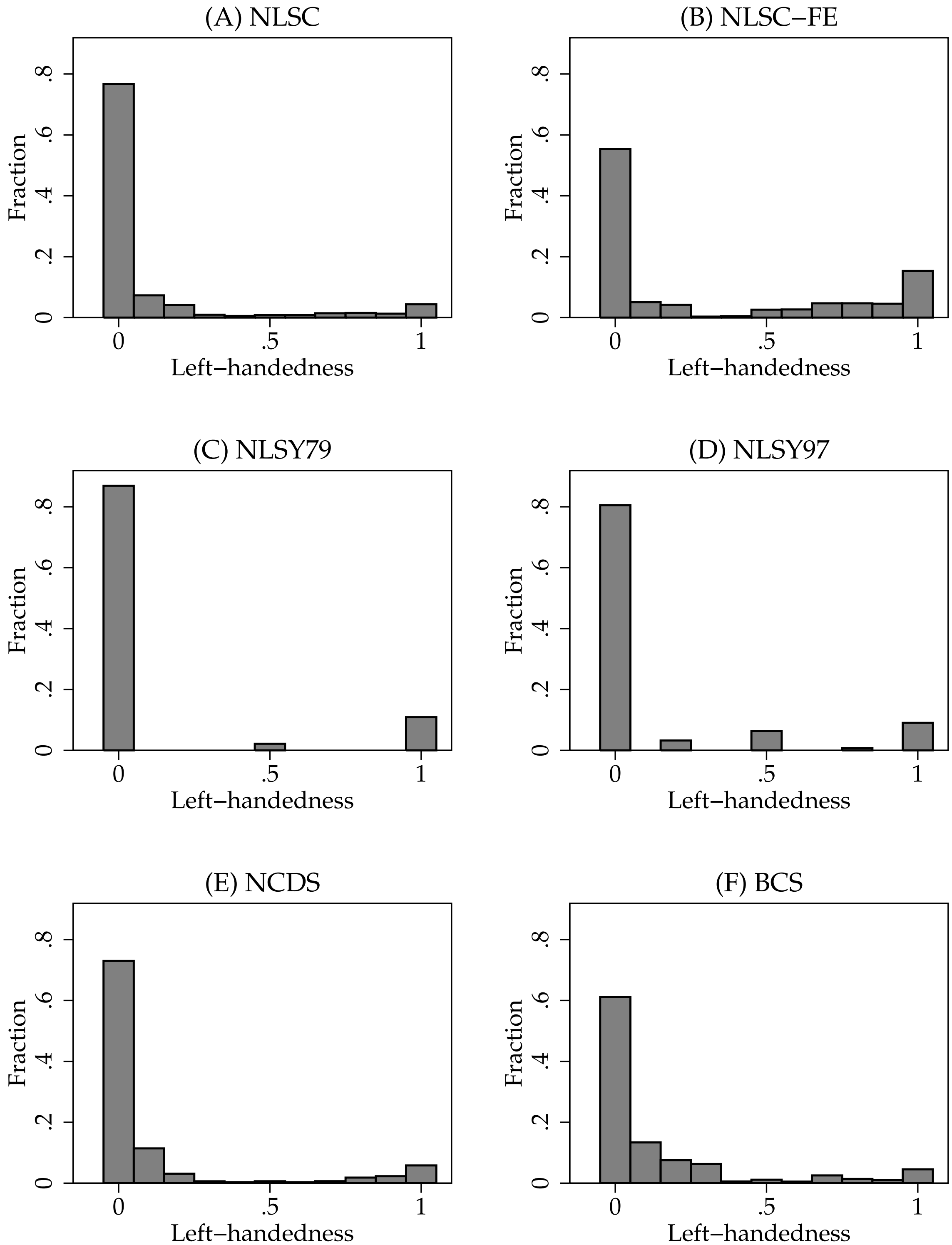

Figure 2: Cognitive Skill Distribution by Handedness (NLSC)

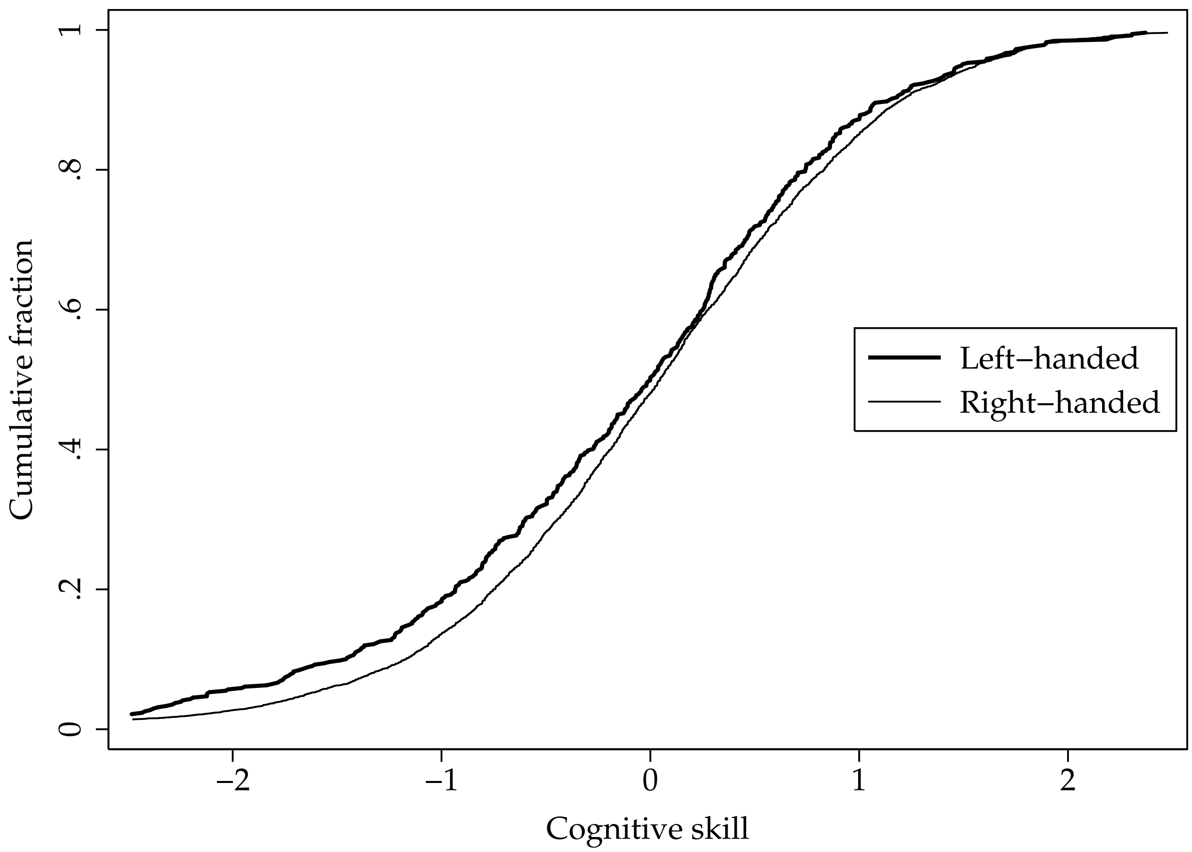

Figure 3: Cognitive Skill Distribution by Handedness (US Sample)

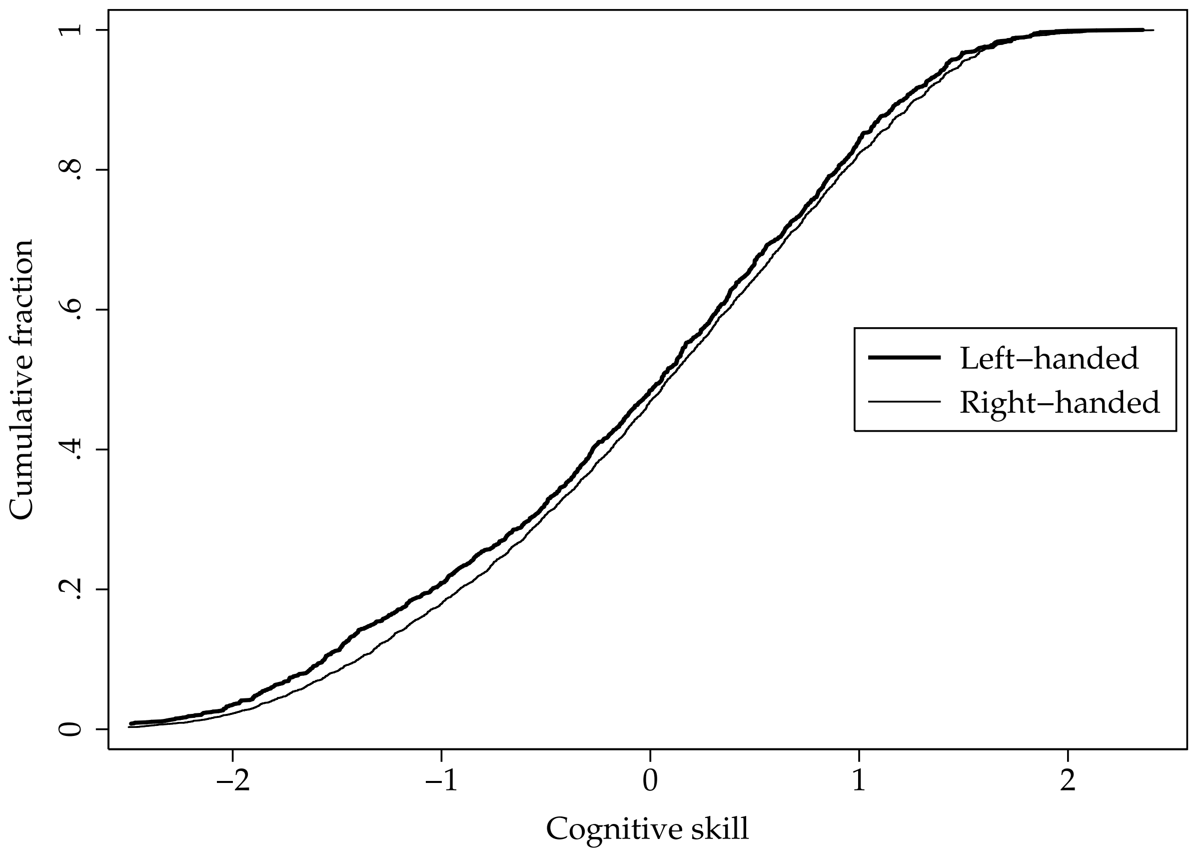

Figure 4: Cognitive Skill Distribution by Handedness (UK Sample)

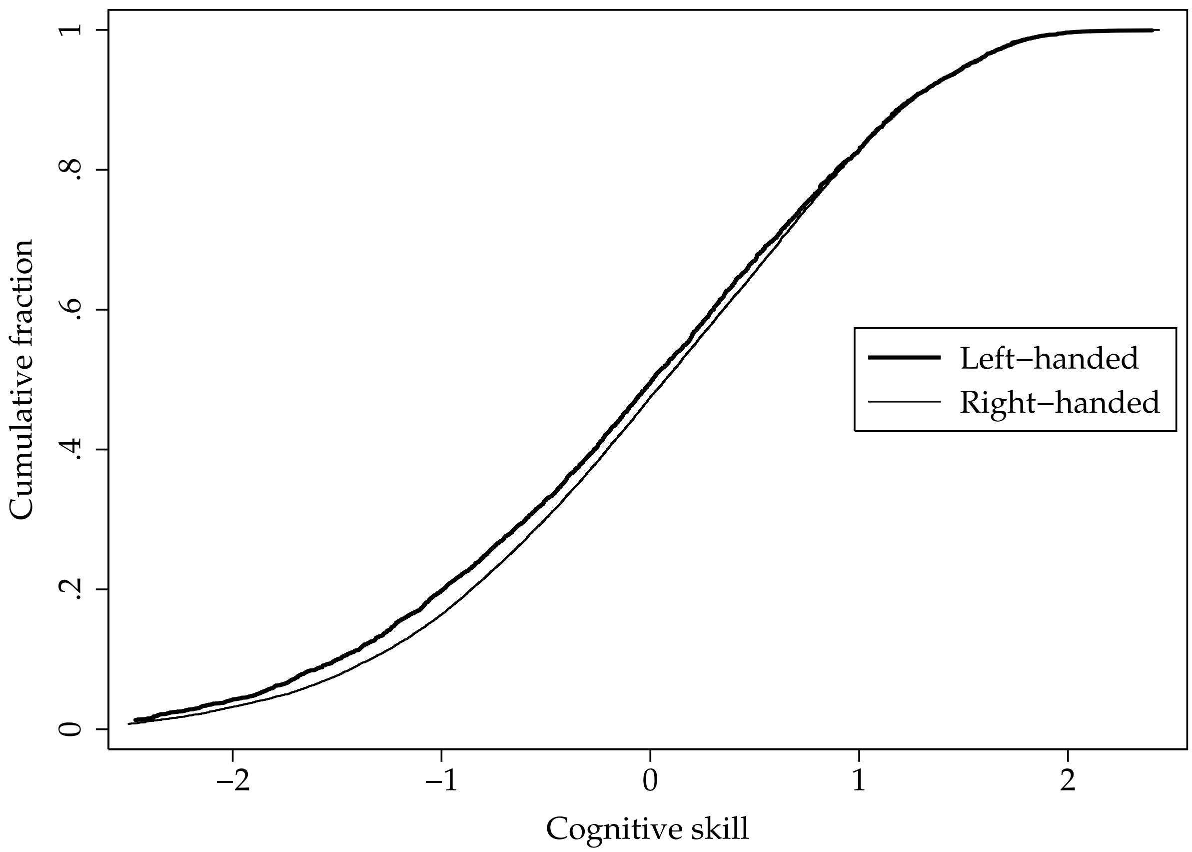

Figure 5: Wage Distribution by Handedness (NLSY79 Sample)

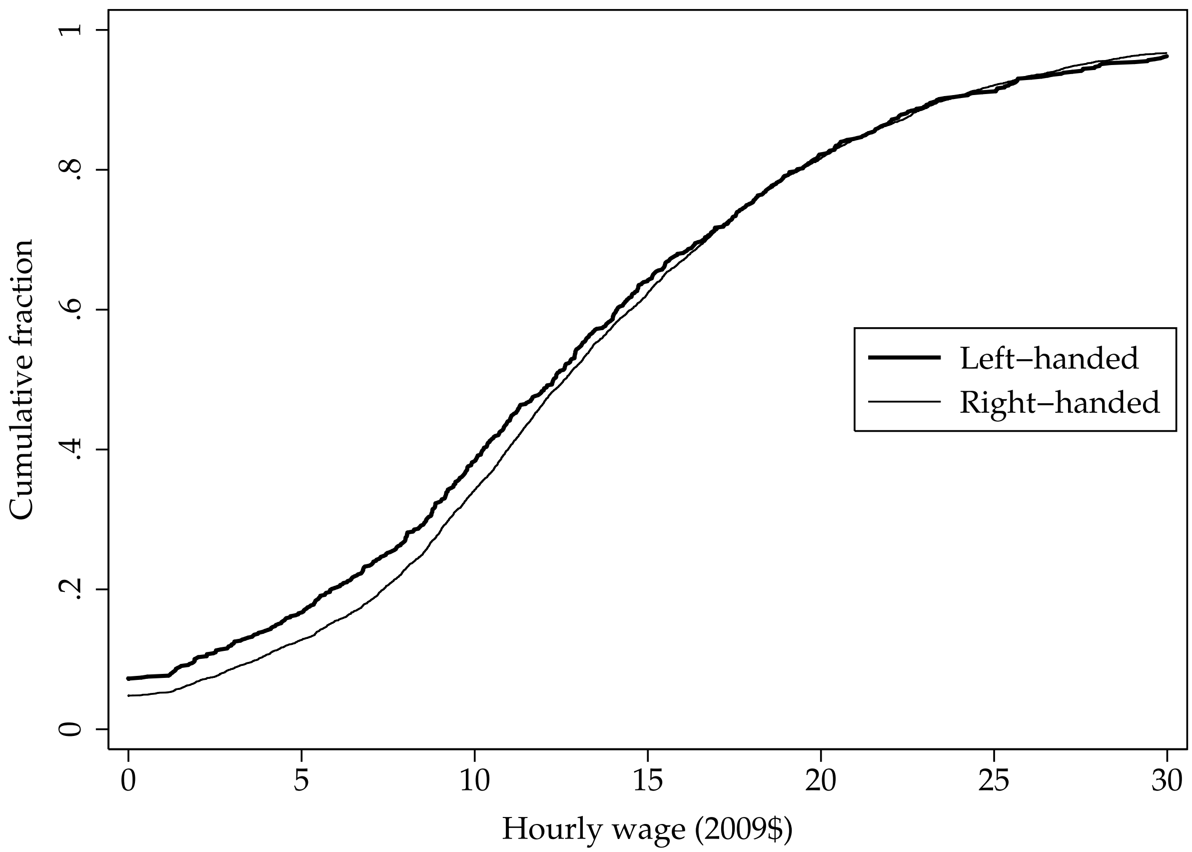

Figure 6: Wage Distribution by Handedness (NLSY97 Sample)

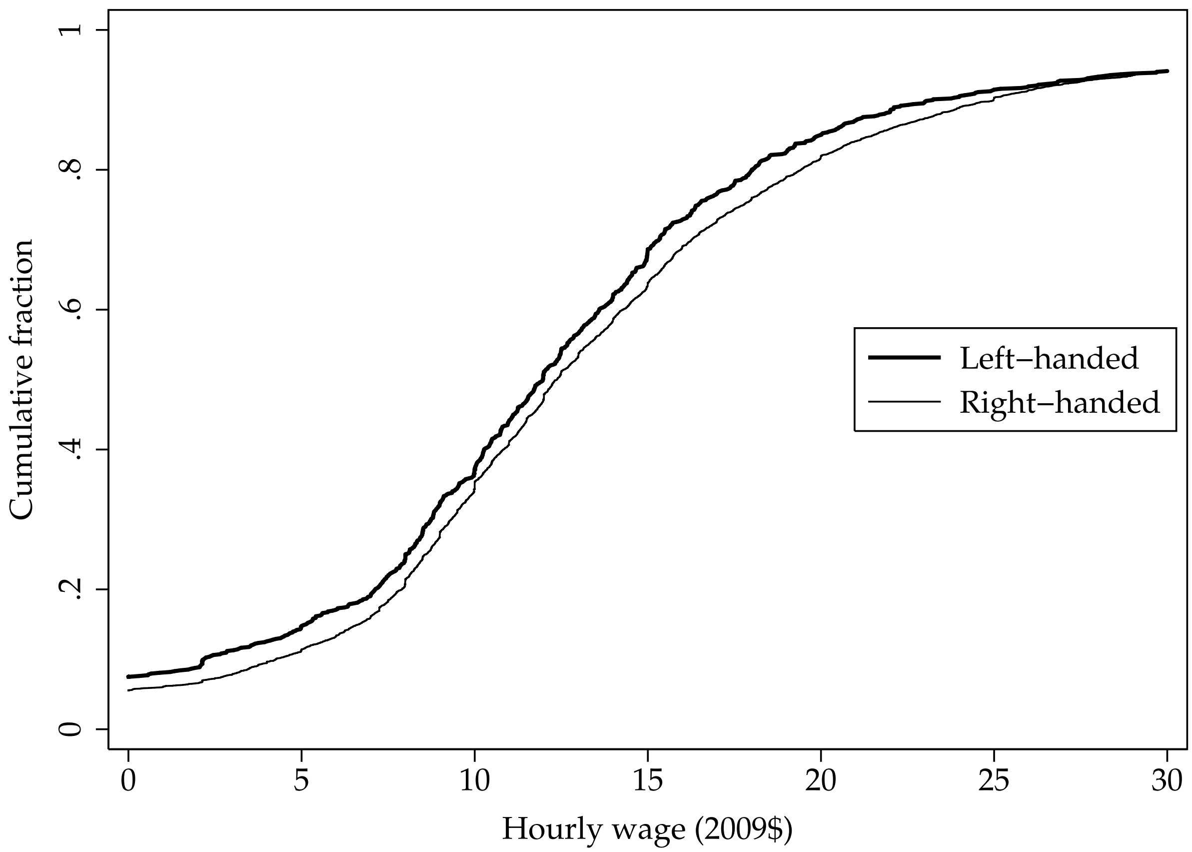

Figure 7: Wage Distribution by Handedness (NCDS Sample)

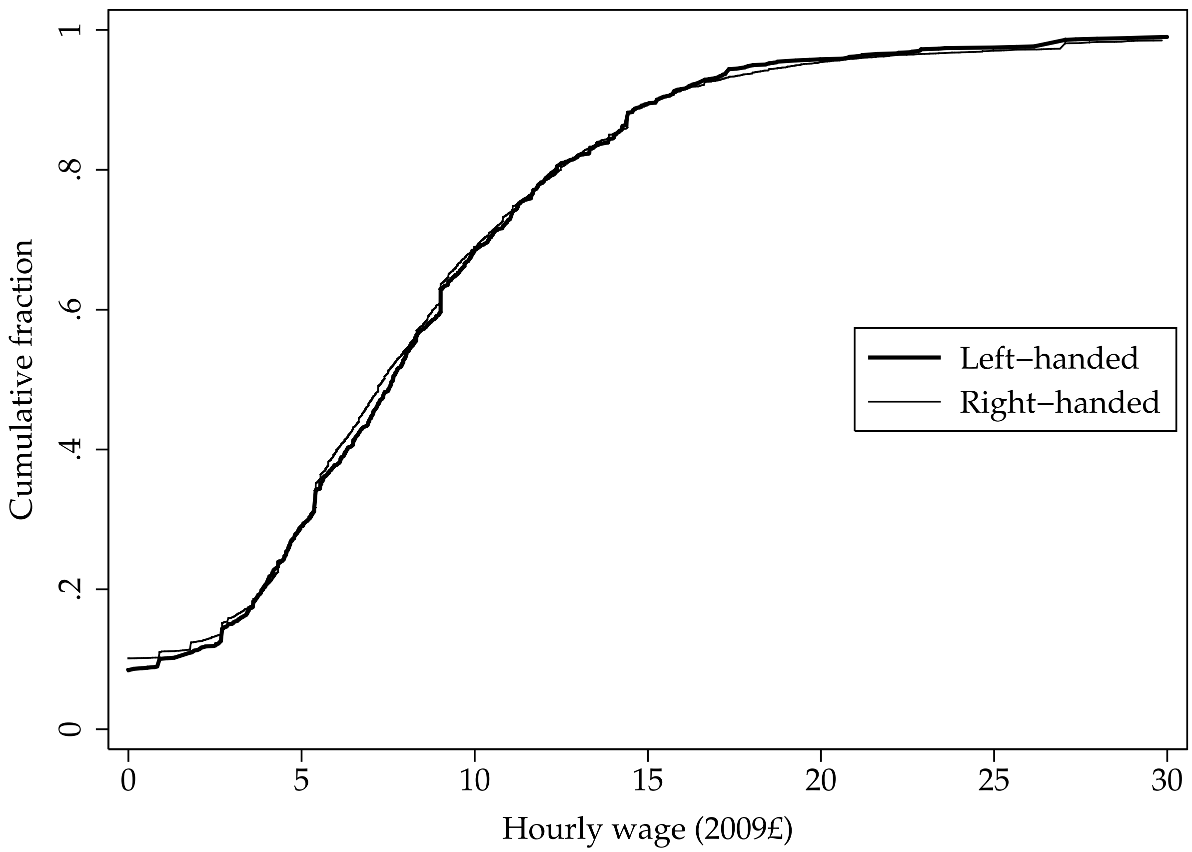

Figure 8: Wage Distribution by Handedness (BCS Sample)

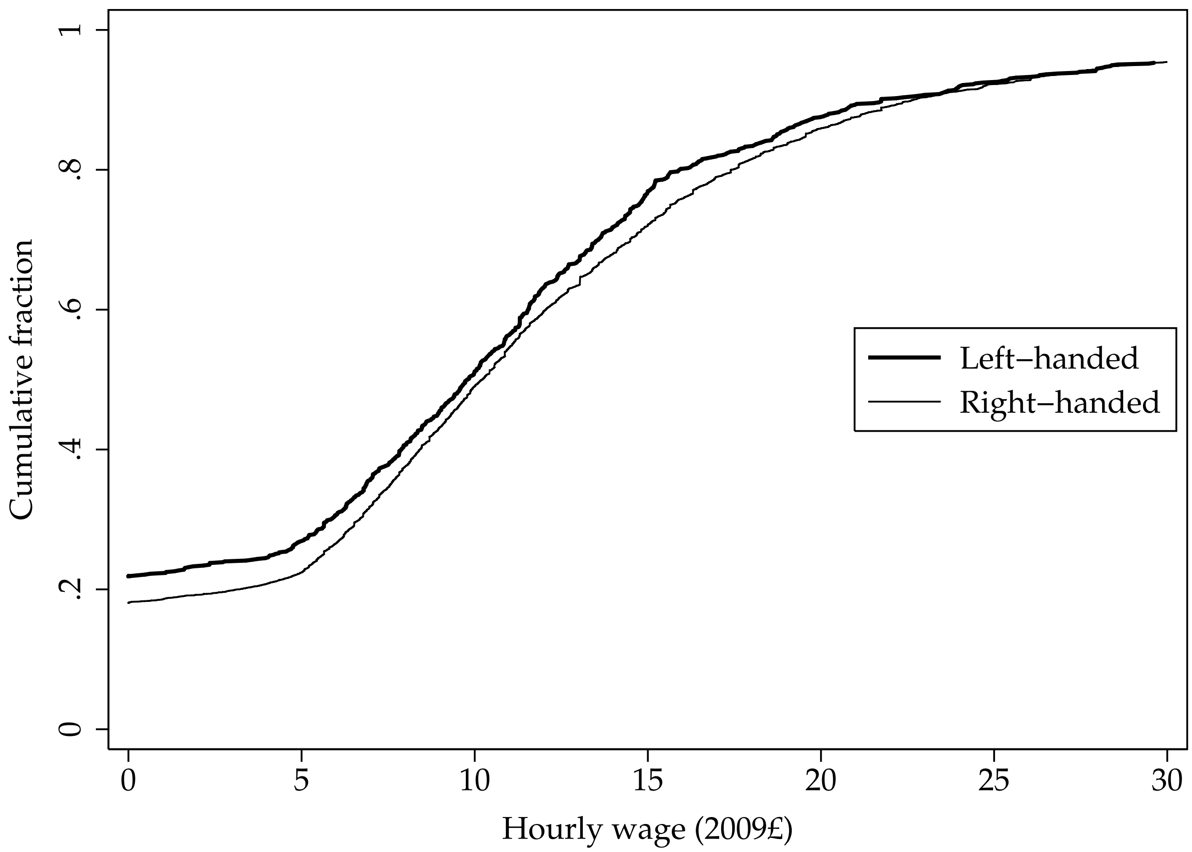

Table 1: Summary Statistics

	(1) NLSC	(2) NLSC-FE	(3) NLSY79	(4) NLSY97	(5) NCDS58	(6) BCS70
(A) Controls						
Year of birth	1987.73	1987.66	1960.65	1982.06	1958.00	1970.00
Left-handed	0.11	0.37	0.13	0.16	0.11	0.11
Female	0.49	0.49	0.52	0.49	0.48	0.49
Birth order	1.95	2.25	2.92	1.77	2.32	2.16
Mother's age at birth	26.66	26.59	26.02	25.67	27.42	25.88
Parental education	13.05	12.95	11.57	12.80	9.50	9.72
Black	0.14	0.19	0.12	0.16	.	.
Hispanic	0.08	0.07	0.07	0.14	.	.
Mother left-handed	0.11	0.15	.	.	.	.
Birthweight (lbs)	6.95	6.90	.	.	7.19	7.27
Birth complications	0.05	0.06	.	.	0.09	0.10
Mother smoked	0.26	0.27	.	.	0.38	0.42
(B) Outcomes						
Cognitive skill	0.00	-0.14	-0.00	-0.00	0.00	0.00
Behavior problem	0.08	0.09	0.08	0.06	0.06	0.05
High school dropout	.	.	0.15	0.18	0.24	0.23
High school graduate	.	.	0.65	0.48	0.47	0.42
College graduate	.	.	0.19	0.29	0.26	0.34
Hourly wage	.	.	13.43	14.06	8.48	11.32
N	4,956	1,234	5,532	6,183	16,712	13,863

Notes: Mean values of each variable are shown by sample. Sample sizes refer to the number of individuals for whom handedness is observed.

Table 2: Determinants of Left-Handedness

	(1) NLSC	(2) NLSC-FE	(3) Pooled US	(4) NLSY79	(5) NLSY97	(6) Pooled UK	(7) NCDS58	(8) BCS70
Female	-0.032***	-0.043***	-0.028***	-0.025***	-0.030***	-0.027***	-0.034***	-0.017***
	(0.009)	(0.016)	(0.007)	(0.009)	(0.009)	(0.004)	(0.005)	(0.006)
Birth order	-0.011***	-0.023	-0.006**	-0.007***	-0.004	0.002	0.002	0.003
	(0.004)	(0.014)	(0.002)	(0.003)	(0.005)	(0.002)	(0.002)	(0.003)
Mother's age at birth	0.002	0.026	0.001	0.001	0.001	-0.001	-0.001	-0.001
	(0.002)	(0.020)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Parental education	-0.002		0.001	-0.000	0.001	-0.001	-0.001	-0.000
	(0.002)		(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Black	0.030**		0.020**	0.028*	0.014			
	(0.014)		(0.010)	(0.015)	(0.013)			
Hispanic	-0.021		0.010	-0.014	0.021			
	(0.015)		(0.012)	(0.018)	(0.015)			
Mother left-handed	0.049***							
	(0.015)							
Birthweight (lbs)	-0.002	-0.004				-0.004***	-0.005***	-0.004
	(0.003)	(0.005)				(0.001)	(0.002)	(0.002)
Birth complications	0.049**	0.045				0.015**	0.016*	0.015
	(0.024)	(0.043)				(0.006)	(0.009)	(0.009)
Mother smoked	0.007	0.024				0.006	0.008	0.003
	(0.011)	(0.032)				(0.004)	(0.005)	(0.006)
R^2	0.018	0.463	0.006	0.005	0.004	0.003	0.004	0.002
N	4,956	4,956	11,715	5,532	6,183	28,473	15,685	12,788
F (infant health)	0.118	0.484	.	.	.	0.000	0.002	0.170

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* $p<.10$ ** $p<.05$ *** $p<.01$). Standard errors are clustered by family in the NLSC samples. Each column is an OLS regression of a binary measure left-handedness on the set of controls shown above. Column (2) includes mother fixed effects and clusters standard errors by mother. The pooled samples in columns (3) and (6) include an indicator specifying which individual sample the observation comes from. Also included but not shown are indicators for year of birth and for missing birth order, maternal education, birthweight, and maternal left-handedness.At the bottom of each column is the p-value from an F-test of the joint significance of birthweight, birth complications, and mother smoked during pregnancy.

Table 3: Left-Handedness and Cognitive Skills

	(1) NLSC	(2) NLSC-FE	(3) Pooled US	(4) NLSY79	(5) NLSY97	(6) Pooled UK	(7) NCDS58	(8) BCS70
Cognitive skill	-0.100**	-0.157***	-0.077***	-0.042	-0.099***	-0.073***	-0.070***	-0.076***
	(0.044)	(0.058)	(0.025)	(0.035)	(0.034)	(0.019)	(0.024)	(0.029)
N	4,682	1,172	10,386	5,290	5,096	26,430	15,598	10,832
Math score	-0.092**	-0.134**	-0.070***	-0.029	-0.098***	-0.066***	-0.059**	-0.076**
	(0.045)	(0.061)	(0.025)	(0.036)	(0.036)	(0.019)	(0.024)	(0.030)
N	4,681	1,172	10,378	5,290	5,088	26,194	15,590	10,604
Reading score	-0.093**	-0.158***	-0.073***	-0.047	-0.087**	-0.069***	-0.071***	-0.065**
	(0.043)	(0.058)	(0.025)	(0.036)	(0.034)	(0.019)	(0.024)	(0.030)
N	4,679	1,170	10,386	5,290	5,096	26,422	15,592	10,830
Bottom 10%	0.034**	0.036	0.036***	0.026**	0.042***	0.025***	0.023***	0.028***
	(0.015)	(0.022)	(0.009)	(0.012)	(0.012)	(0.006)	(0.008)	(0.010)
N	4,682	1,172	10,386	5,290	5,096	26,430	15,598	10,832
Top 10%	-0.010	-0.019	-0.019**	-0.016	-0.020*	-0.002	0.003	-0.010
	(0.013)	(0.020)	(0.008)	(0.011)	(0.011)	(0.006)	(0.007)	(0.009)
N	4,682	1,172	10,386	5,290	5,096	26,430	15,598	10,832
Coding speed			-0.124***	-0.099***	-0.134***			
			(0.026)	(0.035)	(0.037)			
N			10,316	5,290	5,026			
Copying designs						-0.116***	-0.116***	-0.121***
						(0.020)	(0.026)	(0.030)
N						25,243	14,232	11,011

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* $p<.10$ ** $p<.05$ *** $p<.01$). Standard errors are clustered by family in the NLSC samples. Each coefficient comes from a regression of the outcome variable on a binary measure of left-handedness and the other controls listed in the notes to table 2. The cognitive, math, reading, coding speed and copying designs outcomes are Z-scores normalized by age. The top and bottom 10% outcomes are binary variables. See the text for further details.

Table 4: Left-Handedness and Disabilities

	(1) NLSC	(2) NLSC-FE	(3) Pooled US	(4) NLSY79	(5) NLSY97	(6) Pooled UK	(7) NCDS58	(8) BCS70
Behavior problem	0.034**	0.048**	0.016**	0.016	0.016*	0.013***	0.016**	0.010
	(0.014)	(0.021)	(0.007)	(0.012)	(0.009)	(0.005)	(0.007)	(0.007)
μ_R	0.077	0.078	0.070	0.082	0.060	0.056	0.059	0.051
N	4,799	1,197	11,188	5,005	6,183	24,721	13,700	11,021
Mentally retarded	0.009*	0.013**	0.007**	0.009	0.005*	0.011***	0.011***	0.013**
	(0.005)	(0.007)	(0.003)	(0.006)	(0.003)	(0.004)	(0.004)	(0.006)
μ_R	0.004	0.001	0.010	0.017	0.003	0.022	0.008	0.038
N	4,793	1,196	11,715	5,532	6,183	25,345	13,576	11,769
Speech problem	0.018**	0.021*			0.004	0.015**	0.020**	0.010
	(0.007)	(0.011)			(0.007)	(0.007)	(0.010)	(0.011)
μ_R	0.012	0.015			0.034	0.159	0.159	0.159
N	4,793	1,196			6,183	28,390	15,645	12,745
Learning disability	0.022**	0.026			0.031***			0.006
	(0.011)	(0.017)			(0.011)			(0.005)
μ_R	0.042	0.049			0.088			0.014
N	4,793	1,196			6,183			8,777
Digit span: forward	0.004	-0.094						-0.015
	(0.049)	(0.071)						(0.031)
N	4,495	1,126						10,510
Digit span: backward	-0.105**	-0.195**						
	(0.050)	(0.076)						
N	4,494	1,125						

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* p<.10 ** p<.05 *** p<.01). Standard errors are clustered by family in the NLSC samples. Each coefficient comes from a regression of the outcome variable on a binary measure of left-handedness and the other controls listed in the notes to table 2. All outcomes are binary except for the digit span scores, which are Z-scores normalized by age. Below each coefficient on a binary outcome is listed the mean of that outcome for right-handed individuals. See the text for further details.

Table 5: Left-Handedness and Wages

	(1) Pooled US	(2) NLSY79	(3) NLSY97	(4) Pooled UK	(5) NCDS58	(6) BCS70
Hourly wage (mean)	-0.833***	-0.766**	-0.847**	-0.527***	-0.282	-0.869***
	(0.246)	(0.305)	(0.375)	(0.174)	(0.182)	(0.330)
μ_R	13.826	13.495	14.168	9.738	8.486	11.403
N	10,949	5,483	5,466	17,337	9,999	7,338
Hourly wage (median)	-0.947***	-0.761**	-0.718**	-0.199	-0.052	-0.876***
	(0.222)	(0.314)	(0.356)	(0.133)	(0.135)	(0.307)
μ_R	12.479	12.595	12.376	8.421	7.370	10.217
N	10,949	5,483	5,466	17,337	9,999	7,338
Low wage	0.039***	0.040***	0.037***	0.020**	-0.000	0.048***
	(0.008)	(0.013)	(0.011)	(0.009)	(0.010)	(0.015)
μ_R	0.082	0.086	0.078	0.154	0.125	0.192
N	10,949	5,483	5,466	17,337	9,999	7,338
Ln(hourly wage)	-0.060***	-0.057**	-0.058**	-0.035**	-0.041**	-0.028
	(0.018)	(0.026)	(0.025)	(0.016)	(0.020)	(0.027)
N	10,348	5,202	5,146	15,003	9,011	5,992
Ln(censored wage)	-0.083***	-0.081***	-0.082***	-0.059***	-0.028	-0.103***
	(0.017)	(0.025)	(0.024)	(0.017)	(0.020)	(0.031)
N	10,949	5,483	5,466	17,337	9,999	7,338
Ln(non-low wage)	-0.033**	-0.028	-0.033	-0.024*	-0.024	-0.025
	(0.015)	(0.021)	(0.020)	(0.014)	(0.017)	(0.023)
N	9,996	4,986	5,010	14,669	8,764	5,905

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* p<.10 ** p<.05 *** p<.01). Each coefficient comes from a regression of the outcome variable on a binary measure of left-handedness and the other controls listed in the notes to table 2. The first row uses OLS regressions to estimate mean differences in the hourly wage, while the second row uses quantile regressions to estimate median differences. The low wage outcome is an indicator for wages less than three dollars or two pounds. The censored wage replaces low wages with three dollars or two pounds, while the non-low wage excludes such observations. Below the first three rows are respectively the mean hourly wage, the median hourly wage, and the proportion with low wages for right-handed individuals. See the text for further details.

Table 6: Robustness to Alternate Measures of Left-Handedness

	(1) NLSC	(2) NLSC-FE	(3) Pooled US	(4) NLSY79	(5) NLSY97	(6) Pooled UK	(7) NCDS58	(8) BCS70
(A) Cognitive score								
Left-handed	-0.100**	-0.157***	-0.077***	-0.042	-0.099***	-0.073***	-0.070***	-0.076***
	(0.044)	(0.058)	(0.025)	(0.035)	(0.034)	(0.019)	(0.024)	(0.029)
Left-handedness	-0.132***	-0.166**	-0.082***	-0.029	-0.128***	-0.103***	-0.107***	-0.098***
	(0.051)	(0.070)	(0.028)	(0.037)	(0.041)	(0.021)	(0.026)	(0.035)
Clearly left-handed	-0.085*	-0.144**	-0.066**	-0.016	-0.110***	-0.055***	-0.059**	-0.048
	(0.046)	(0.065)	(0.028)	(0.038)	(0.042)	(0.019)	(0.025)	(0.031)
Not mentally retarded	-0.088**	-0.140**	-0.072***	-0.037	-0.095***	-0.060***	-0.055**	-0.065**
	(0.043)	(0.054)	(0.024)	(0.035)	(0.034)	(0.019)	(0.025)	(0.030)
(B) Hourly wage								
Left-handed			-0.833***	-0.766**	-0.847**	-0.527***	-0.282	-0.869***
			(0.246)	(0.305)	(0.375)	(0.174)	(0.182)	(0.330)
Left-handedness			-0.983***	-0.711**	-1.208***	-0.447**	-0.307	-0.656*
			(0.276)	(0.322)	(0.455)	(0.196)	(0.207)	(0.390)
Clearly left-handed			-0.890***	-0.607*	-1.132**	-0.401**	-0.204	-0.702**
			(0.283)	(0.327)	(0.475)	(0.179)	(0.187)	(0.354)
Not mentally retarded			-0.761***	-0.675**	-0.795**	-0.512***	-0.200	-0.954***
			(0.248)	(0.308)	(0.377)	(0.180)	(0.191)	(0.341)

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* $p<.10$ ** $p<.05$ *** $p<.01$). Standard errors are clustered by family in the NLSC samples. Each coefficient comes from a regression of the outcome variable on a measure of left-handedness and the other controls listed in the notes to table 2. The first row of each panel is the baseline specification found in previous tables. The second row of each panel replaces the binary measure of handedness with a continuous measure. The third row of each panel uses the binary measure of handedness but excludes mixed-handed individuals. The fourth row of each panel uses the binary measure of handedness but excludes mentally retarded individuals. See the text for further details.

Table 7: Left-Handedness and Educational Attainment

	(1) Pooled US	(2) NLSY79	(3) NLSY97	(4) Pooled UK	(5) NCDS58	(6) BCS70
High school dropout	0.002	-0.003	0.006	0.015	0.009	0.024
	(0.009)	(0.013)	(0.013)	(0.010)	(0.013)	(0.015)
μ_R	0.165	0.147	0.181	0.236	0.241	0.229
N	11,715	5,532	6,183	18,789	10,691	8,098
High school graduate	0.026**	0.028	0.025	-0.008	-0.006	-0.009
	(0.013)	(0.019)	(0.017)	(0.011)	(0.015)	(0.018)
μ_R	0.562	0.651	0.479	0.453	0.474	0.426
N	11,715	5,532	6,183	18,789	10,691	8,098
College graduate	-0.030***	-0.024	-0.034**	-0.006	0.001	-0.017
	(0.010)	(0.014)	(0.014)	(0.010)	(0.013)	(0.016)
μ_R	0.246	0.196	0.292	0.297	0.262	0.342
N	11,715	5,532	6,183	18,789	10,691	8,098
Education missing	0.002	-0.001	0.004	-0.001	-0.004	0.003
	(0.005)	(0.003)	(0.008)	(0.003)	(0.004)	(0.003)
μ_R	0.028	0.006	0.048	0.014	0.023	0.003
N	11,715	5,532	6,183	18,789	10,691	8,098

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* p<.10 ** p<.05 *** p<.01). Each coefficient comes from a regression of the outcome variable on a binary measure of left-handedness and the other controls listed in the notes to table 2. Below each coefficient is the mean of the outcome variable for right-handed individuals. See the text for further details.

Table 8: Heterogeneity by Gender

	(1) NLSC	(2) NLSC-FE	(3) Pooled US	(4) NLSY79	(5) NLSY97	(6) Pooled UK	(7) NCDS58	(8) BCS70
(A) Cognitive score								
Males	-0.117*	-0.255*	-0.092***	-0.059	-0.107**	-0.073***	-0.076**	-0.067*
	(0.063)	(0.150)	(0.035)	(0.050)	(0.048)	(0.025)	(0.033)	(0.040)
N	2,399	595	5,144	2,551	2,593	13,536	8,020	5,516
Females	-0.084	-0.213*	-0.063*	-0.027	-0.086*	-0.073***	-0.064*	-0.086**
	(0.060)	(0.115)	(0.034)	(0.047)	(0.049)	(0.027)	(0.035)	(0.043)
N	2,283	577	5,242	2,739	2,503	12,894	7,578	5,316
(B) Hourly wage								
Males			-0.643*	-0.612	-0.633	-0.466*	-0.352	-0.661
			(0.370)	(0.459)	(0.563)	(0.243)	(0.265)	(0.470)
N			5,376	2,653	2,723	8,400	4,955	3,445
Females			-1.027***	-0.943**	-1.043**	-0.570**	-0.179	-1.072**
			(0.313)	(0.396)	(0.475)	(0.248)	(0.240)	(0.467)
N			5,573	2,830	2,743	8,937	5,044	3,893

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* p<.10 ** p<.05 *** p<.01). Standard errors are clustered by family in the NLSC samples. Panel (A) replicates the first row of table 3, splitting the sample by gender. Panel (B) replicates the first row of table 5, splitting the sample by gender. See the text for further details.

Table 9: Explaining The Wage Gap

	(1) Pooled US	(2) NLSY79	(3) NLSY97	(4) Pooled UK	(5) NCDS58	(6) BCS70
Baseline estimate	-0.833***	-0.766**	-0.847**	-0.527***	-0.282	-0.869***
	(0.246)	(0.305)	(0.375)	(0.174)	(0.182)	(0.330)
+ cognitive skill controls	-0.641***	-0.690**	-0.581	-0.396**	-0.156	-0.712**
	(0.239)	(0.293)	(0.368)	(0.167)	(0.171)	(0.322)
+ disability controls	-0.591**	-0.636**	-0.539	-0.375**	-0.150	-0.687**
	(0.238)	(0.291)	(0.366)	(0.167)	(0.171)	(0.321)
+ education controls	-0.549**	-0.600**	-0.496	-0.400**	-0.184	-0.660**
	(0.232)	(0.285)	(0.357)	(0.162)	(0.169)	(0.309)
N	10,949	5,483	5,466	17,337	9,999	7,338

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* $p<.10$ ** $p<.05$ *** $p<.01$). The first row replicates the first row of table 5. The second row adds controls for math and reading skills. The third row adds further controls for mental retardation and emotional/behavioral problems. The fourth row adds further controls for educational attainment. See the text for further details.

Table 10: Left-Handedness and Other Gaps

	Cognitive skill			Hourly wage	
	(1)	(2)	(3)	(4)	(5)
	NLSC	Pooled US	Pooled UK	Pooled US	Pooled UK
Left-handed	-0.100**	-0.077***	-0.073***	-0.833***	-0.527***
	(0.044)	(0.025)	(0.019)	(0.246)	(0.174)
Female	0.031	0.141***	0.032***	-3.378***	-4.301***
	(0.026)	(0.017)	(0.011)	(0.166)	(0.112)
Parental education	0.122***	0.115***	0.129***	0.459***	0.663***
	(0.008)	(0.004)	(0.003)	(0.036)	(0.041)
Black	-0.624***	-0.720***		-2.309***	
	(0.050)	(0.025)		(0.245)	
Hispanic	-0.259***	-0.261***		-0.096	
	(0.064)	(0.032)		(0.282)	
Birthweight (lbs)	0.027***		0.083***		0.321***
	(0.008)		(0.005)		(0.042)
N	4,682	10,386	26,430	10,949	17,337

Notes: Heteroskedasticity robust standard errors are reported in parentheses (* p<.10 ** p<.05 *** p<.01). Standard errors are clustered by family in the NLSC samples. Each column is a regression of the outcome variable on a binary measure of left-handedness and the other controls listed in the notes to table 2. See the text for further details.