Senatorial signatures
Absence of male-female differences in left-handedness

Nancy L. Segal, *California State University, Fullerton*
Francisca J. Niculae, *California State University, Fullerton*

Abstract. **A greater frequency of left-handedness among males than females has been observed in general populations. Past studies have explained this difference with reference to males' greater susceptibility to adverse birth events, while more recent studies have identified other contributing factors. On January 16, 2020, U.S. senators signed an oath to act impartially during the president's impeachment trial. This televised event allowed direct comparison of the proportion of right-handedness and left-handedness in a professionally accomplished sample of males and females. As expected, no sex difference in the proportion of left-handed senators was found, although the small sample size offered low statistical power. Replicating this finding with a larger sample would support the view that left-handedness among select groups of males is linked to genetic factors.**

Key words: Left-handedness, right-handedness, males, females

The estimated frequency of left-handedness across geographic regions is 10.6% but varies from 9.3% to 18.1% as a result of assessment procedures, cultural factors, and other influences (Papadatou-Pastou et al., 2020). However, a greater frequency of left-handedness among males than females has consistently been observed (Papadatou-Pastou et al., 2008; Sommer et al., 2008). A recent meta-analysis indicated an approximately 2% higher representation of left-handed males than females across various classification schemes (e.g., forced choice and non-right-handedness) (Papadatou-Pastou et al., 2020).

Explanations for the sex difference in handedness have included genetic models involving gene penetrance, modifier genes, maternal effects, greater cultural pressures on women to conform to conventional practices, and males' greater susceptibility to birth stressors. Recent studies, however, have produced mixed support for the effects of adverse birth factors on left-handedness. Papadatou-Pastou et al. (2008) found that across a range of birth stressors, only maternal age was linked to left-handedness in offspring, albeit weakly. Medland et al. (2009) showed the effects of birthweight on left-handedness in Australian and Dutch samples, but a greater proportion of the variance was explained by unique environmental factors after correcting for these covariates. The authors did not dismiss the possibility that unknown covariates may play a meaningful role in handedness, suggesting future study of birth stress, anoxia, and ultrasound exposure. A study using triplet samples from Japan and the Netherlands found that within-family and between-family analyses suggested that left-handedness is associated with lower birthweight, even after controlling for gestational age. It was proposed that developmental differences between left- and right-handers are explained by a shared etiology associated with low birthweight (Heikkilä et al., 2018; also see Segal, 2018). De Kovel et al. (2019) found that hand preference was influenced by early life factors, such as birthweight, sex, and membership in a multiple birth set, but these factors collectively showed minimal predictive value for individual hand preference. The idea that a random model of embryonic development may account for the findings was put forth.

In contrast, populations composed of academically advanced individuals, such as students seeking admission to colleges and graduate programs, have shown a lack of difference in the relative frequency of male left-handers (n = 931, 90%) and female left-handers (n = 646, 91%) (Segal, 1984). The explanation given for this finding was that males whose left-handedness was due to birth complications would have suffered some degree of cognitive impairment because of adverse birth effects,

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Correspondence: Nancy L. Segal, California State University, Fullerton.
Email: *nsegal@fullerton.edu*

thereby self-selecting out of this college- and university-bound sample. Some left-handed females should also be among this excluded group, although the proportion should be smaller, given that female infants are better able to withstand prenatal and perinatal difficulties than male infants (Kent et al., 2012; Stevenson et al., 2000). Again, it is noted that not all studies have supported an association between early life history adversity and handedness. For example, Nicholls et al. (2012) disassociated adverse birth factors affecting cognition from those factors affecting hand preference.

The elevated frequency of left-handedness among individuals with specific medical and health conditions is also well documented. Both increased left-handedness and left-eyedness were detected in males and females with Williams-Beuren syndrome (Van Strien et al., 2005). This disorder, currently known as Williams syndrome, is associated with a microdeletion on the long arm of chromosome 7, resulting in congenital heart defects, insufficient growth, mental retardation, and, in some cases, elevated calcium levels in infancy (Sugayama et al., 2007). It was suggested that these findings reflect a slower maturation rate, enabling deviation from the typical pattern of laterality.

In contrast with the foregoing, related research has reported associations between left-handedness and various talents, in addition to various medical complaints (Papadatou-Pastou, & Tomprou, 2015; Satz & Soper, 1986; Smith et al., 1989; Van der Elst, 2008). Benbow (1986) observed that mathematically and verbally precocious youth displayed high frequencies of left- and mixed-handedness, as well as asthma and other allergies; the author speculated that the shared effects of testosterone on the nervous and immune systems during prenatal development were responsible. Benbow further proposed that such academically advanced individuals have elevated bihemispheric representation of cognitive function relative to right-handers. In a comprehensive review, Mzraik and Dombrowski (2010) indicated that gifted children are disproportionately non-right-handed and that mathematically and musically talented children show more bilateral brain organization. They also noted that gifted individuals and individuals with schizophrenia tend to be left-handed, and that gifted individuals and individuals with autism spectrum disorder have elevated frequencies of allergies and autoimmune conditions. These seemingly conflicting findings were resolved by the suggestion of shared neuropathological mechanisms. Clearly, the literature presents a mixed picture of the associations between giftedness and handedness, especially given the myriad definitions linked to the concept of giftedness and the variety of handedness assessment procedures.

Handedness and political science research

Hand preference has been of past, as well as present, interest to political science scholars. This interest is reflected in studies of handedness and conservatism-liberalism (Bernabel & Oliveira, 2017), political cognition (Masters, 1989), political orientation (McCann, 2019), and support for selected political candidates (Prichard & Christman, 2020). Moreover, certain features of handedness, such as consistency of hand preference, have been linked to authoritarianism and other psychological variables (Lyle & Grillo, 2020; Prichard & Christman, 2020). Sex and gender have also been significant variables in political science research, evident in studies of political participation (Coffé & Blozendahl, 2010), publication patterns (Teele & Thelen, 2017), and feminism and reproductive strategies (Liesen, 1995). However, to our knowledge, the representation of left-handers and right-handers among male and female members of the U.S. Senate has never been investigated.

On January 16, 2020, U.S. senators signed an oath pledging to show "impartial justice" in their rendering of a verdict in the impeachment trial of President Donald J. Trump. This televised event allowed direct assessment and comparison of right-handedness and left-handedness in an intellectually accomplished and high-achieving sample. It was hypothesized that the proportion of male and female left-handed senators would not be statistically different. The sample size (N = 100) is modest, necessarily limited by the allocation of two senators per state. While cautious interpretation of the findings is encouraged, it is recognized that unique samples pose research opportunities that can be used fruitfully and expanded upon in the future.

Methods

January 16, 2020, marked the first day of the impeachment trial of President Trump. As part of that procedure, the 99 senators present added their signatures to an oath book, pledging to show "impartial justice" in their rendering of a verdict to impeach or not to impeach. This event was televised, offering a unique opportunity to directly observe the proportion of left-handed and right-handed males and females in an intellectually

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advanced and professionally accomplished group of individuals. Senator James Inhofe from Oklahoma was absent on that day, but his right-handed preference was noted in his signing of a document on another occasion (Voices of Oklahoma, 1987), and in a videotaped tossing of a snowball on the Senate floor as part of a statement on the perils of climate change (Cama, 2015). Throwing a ball is a widely used item in self-report handedness inventories and shows a .88 test-retest reliability. Moreover, 99.4% of strongly right-handed individuals indicate throwing a ball with their right hand, while only 2.2% of strongly left-handed individuals would do so (Van Strien, 2002).

The number of right-handed and left-handed male and female senators was observed and recorded by one of the authors during the live broadcast. A reliability check, performed by a laboratory assistant who was blind to the hypothesis, confirmed the final count. The reliability analysis was accomplished using a tape of the hearing that was available on the internet (YouTube, 2020).

It was also of interest to examine the educational attainment of the 100 senators with reference to adults living in the United States. It was expected that a higher proportion of senators would have earned higher academic and/or professional degrees than members of the general population. If demonstrated, this finding would serve as a partial (albeit imperfect) indicator of intellectual acumen, given the varied evidence of links between cognition and hand preference. That is, left-handedness in the absence of adverse nongenetic factors would be suggested, but not demonstrated definitively. Of course, achieving political office involves more than just academic intellect, in that attributes such as resilience and analytical skills contribute to political success (Silvester et al., 2014); surveying these traits among the senators was beyond the scope of the present study. However, associations between handedness and party affiliation (Democrat versus Republican) and handedness and political orientation (left-wing versus right-wing) were examined in view of the recent findings cited here.

Party affiliation and educational attainment were extracted from the home pages of the 100 senators. Political orientation data were retrieved from the GovTrack.us (2019–2021; rankings) and Voteview.com websites (Lewis et al., 2021; scores). The methods used to generate these data are available on each website, cited in the references. All statistical tests are two-tailed.

Results

At the time of the study, the U.S. Senate was composed of 74 male and 26 female senators. A chi-square analysis revealed that the proportion of left-handed male senators (14.9%) did not exceed the proportion of left-handed female senators (7.7%) [$X^2(1, N = 100) = 0.875, p = .35$], as expected. It was also noted that the observed male-female handedness difference of 7.2% exceeds the 2% male-female difference reported globally by Papadatou-Pastou et al. (2020). Male senators were six times as likely to be right-handed, whereas female senators were 12 times as likely to be right-handed. The effect size associated with this result, $\varphi = .094$, suggests a small but not negligible effect of sex on the handedness distributions.

Further analyses showed that very large sample sizes would be required to find a statistically significant difference at the $p < .05$ level. A prior power analysis (z-test for the difference between two independent proportions), using an allocation ratio of 2.85 (74/26), showed that samples of 163 male senators and 465 female senators, or similarly accomplished male and female individuals, would be required to detect a statistically significant handedness difference at a power level $1 - \beta$ of .95 (see Faul et al., 2009). These findings are summarized in Table 1.

Every member of the Senate had earned a bachelor of arts (BA) or bachelor of science (BS) degree, while one senator had earned a doctor of optometry degree at optometry college. This figure of 100% contrasts with the 35% of adults in the United States over the age of 25 who earned similar degrees in 2018 (U.S. Census Bureau, 2019). Moreover, 79% of the senators had earned higher educational or professional degrees (master of arts [MA], juris doctorate, or medical degree) or multiple degrees (e.g., two MAs and a doctorate). Organizing the senators by sex and recoding educational attainment into two categories (BA or BS and all higher degrees) did not show a male-female difference.

Associations between handedness and party affiliation were nonsignificant for the full sample and among

Table 1. U.S. senators organized by handedness and sex.

	Sex	
Handedness	Female	Male
Left	2	11
Right	24	63

$X^2(1, N = 100) = 0.875, p = .35$.

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male and female senators. (The two independent senators, Bernie Sanders of Vermont and Angus King of Maine, were classified as Democrats, based on their voting records.) The total sample was composed of 47 Democrats (41 right-handed, 6 left-handed; 87% and 13%, respectively) and 53 Republicans (46 right-handed and 7 left-handed; 86% versus 13%), $X^2(1, N = 100) = .004$, n.s. The distribution of right- and left-handed senators was then evaluated using Fisher's exact test, given that some cell sizes were less than 5. The male senators included 30 Democrats (26 right-handed and 4 left-handed; 87% versus 13%) and 44 Republicans (37 right-handed and 7 left-handed; 84% versus 16%, Fisher's exact test = 1.00, n.s.). The female senators included 17 Democrats (15 right-handed and 2 left-handed; 88% versus 12%) and 9 Republicans (9 right-handed and 0 left-handed; 100% versus 0%, Fisher's exact test = 0.529, n.s.).

The GovTrack.us data (left-wing versus right-wing ideology rankings) correlated highly with the Voteview.com data (left-wing versus right-wing ideology scores), $r = .89$, $p < .001$, $N = 99$. The analyses presented here are based on the latter, given that Voteview.com is a more widely used site and because information was available for the complete data set; former Georgia senator Kelly Loeffler had been excluded from the GovTrack.us rankings.

Political orientation was uncorrelated with handedness. However, political orientation was correlated significantly with both party affiliation (Democrat versus Republican), $r = .94$, $p < .001$, and with sex, $r = -.22$, $p = .013$. Democratic senators and female senators were more left-wing than Republican senators and male senators. Simple regression analysis using party affiliation as a predictor and political orientation as the dependent variable yielded a significant model, $F(1, 98) = 772.67$, $p < .001$. $R^2 = .89$, such that 89% of the variance in political orientation was explained by party affiliation. B (unstandardized) = .85, SE = .03, $p < .001$, and the t-test for party affiliation were significant, $t = 27.80$, $p < .001$. A second analysis using both party affiliation and sex as predictors also yielded a statistically significant model, $F(2, 97) = 410.83$, $p < .001$, $R^2 = .89$, with a significant change in the F value, $p < .001$. Political affiliation remained as a significant predictor of political orientation, $B = .83$, SE = .03, $t = 27.31$, $p < .001$, as did sex, $B = -.09$, SE = .04, $t = -2.53$, $p < .05$. However, the interaction between party affiliation and sex with reference to political orientation was nonsignificant.

Discussion

The lack of a sex difference in the proportion of left- and right-handers among U.S. senators is consistent with the hypothesis that an intellectually select sample of adult males is represented. Specifically, it suggests that left-handedness in the male senators reflects factors unrelated to nongenetic adverse influences. This interpretation would also apply to the female senators. However, this conclusion, while tentative at present given the low statistical power afforded by the sample of 100 senators, is consistent with associations between pathological left-handedness and reduced birthweight, a known risk factor for cognitive impairment (de Kovel et al., 2019; Linsell et al. 2015), and males' greater IQ variability, resulting in their greater representation at both the upper and lower ends of the IQ distribution (Johnson et al., 2008). Interestingly, de Kovel et al. (2019) found that males were heavier at birth, on average, than females, yet they showed a higher probability of left-handedness. The greater biological prenatal and postnatal biological vulnerability of males than females is well known, as indicated earlier and by Mayoral, Omar, and Penn (2009) and DiPietro and Voegtline (2017).

Despite the lack of a statistically significant sex difference in the proportion of left-handedness, there were considerably more left-handed male than female senators. Males' increased representation at the high end of the IQ distribution (albeit to a lesser degree than at the lower end) may have contributed to this result (Johnson et al., 2008). We believe that the observed lack of a sex difference supports the notion that the male senators' left-handedness is unrelated to early adversity and that the relatively higher proportion of left-handed male senators does not challenge this view. However, caution is urged in accepting our interpretation. It is anticipated, but not certain, that a larger sample of accomplished males and females would yield a statistically significant lack of sex difference in the representation of left-handed members. Therefore, future empirical analyses along these lines are encouraged.

The present finding generates the expectation that the genealogies of the left-handed male senators would include other left-handed family members, suggesting that their left-handedness reflects both genetically based factors (Klar, 2003; Medland et al., 2009) and various nongenetic factors, such as decrement in the genetic control of cerebral volumes (Geschwind et al., 2002). These data were unavailable, but would be of considerable interest to the present report. Both twin and family

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data provide evidence of genetic effects on hand preference (McManus et al., 2013). However, it is likely that left-handers whose handedness was linked to reduced birthweight would have relatively fewer or no left-handed relatives, in contrast with left-handers whose preference is genetically based. It is also expected that the senators' birth histories would be characterized by an absence of adverse prenatal and/or perinatal influences, such as birth stress, anoxia, and ultrasound exposure that may be linked to left-handedness (see Medland et al., 2009). This reasoning would apply to female Senate members as well. The elevated frequency of higher academic degrees earned by the U.S. senators offers additional evidence, albeit imperfect, that left-handedness among the senators is associated with genetic factors and nongenetic influences.

Significant correlations between political orientation with both party affiliation and with sex were not unexpected, given previous findings along these lines (Eriksson, 2018; Lizotte, 2019). However, regression analyses showed that party affiliation was a stronger predictor of political orientation than sex. This finding might identify political affiliation as a more direct measure of political orientation than sex, as well as reflect the relatively small number of female senators. Lastly, an association between political orientation and handedness was not observed. This may be understood, in part, with reference to findings by Prichard and Christman (2016) and Lyle and Grillo (2020) showing that consistency of handedness, rather than handedness per se, is a more sensitive measure of attitudinal variables.

Conclusion and future directions

A point worth emphasizing is that future research on the correlates of left-handedness should strive to organize participants according to the source (familial and/or nongenetic) whenever possible. The occupational status of the members of specific subgroups of male and female left-handers, such as musicians, surgeons, factory workers, and machinists, would be of interest. Attention to hand skill as a related but separate measure of handedness has been suggested as an informative index of handedness-intelligence correlations in the general population (Papadatou-Pastou & Tomprou, 2015), and is worth exploring. Consistency of handedness is another variable important to examine, given its association with various attitudinal measures. To our knowledge, no one has explored these interesting questions using a sample similar to the present one. New opportunities to assess these effects should be available now that the November 2020 election has passed.

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