Exploring digit ratio and handedness in asexual and allosexual individuals

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Asexuality, often characterized as an absence of sexual attraction, is now understood as a spectrum incorporating varying levels of sexual and romantic attraction. Despite growing visibility and scientific interest, asexuality remains stigmatized and often misunderstood as a valid sexual orientation. While previous research has identified biomarkers such as digit ratios (2D:4D) and handedness in the context of homosexuality, their association with asexuality remains underexplored. To address this gap and contribute to the understanding of asexuality as a distinct sexual orientation, the authors conducted an online study recruiting asexual (n = 366) and non-asexual (allosexual; n = 1,305) participants. They collected digit ratio measurements using scans of both right and left hands and assessed handedness using the Edinburgh Handedness Inventory. Results indicated that across all sexual orientations, females had higher left- and right-hand digit ratios than males, consistent with most prior research. Also, consistent with some prior research, exploratory analyses suggested asexual men had elevated rates of non-right-handedness relativo allosexual men. In addition, the authors found nuanced differences, such that sexual orientation, handedness, and the hand used for digit ratio calculations significantly interacted. They found that non-right-handed asexual participants had a lower right-hand-digit ratio than those attracted to more than one gender. Also, non-right-handed asexual participants had a significantly lower left-hand-digit ratio than heterosexual and gay/lesbian participants. Overall, these findings contribute to the limited body of literature on asexuality and highlight the importance of considering the potential complex interaction of multiple biological/prenatal factors in the development of sexual orientation, including asexuality.

KEYWORDS: Asexuality, biomarkers, digit ratios, handedness, sexual orientation

One of the earliest documented accounts of human asexuality was in 1948 when Alfred Kinsey and colleagues included a category "X"—defined as having no socio-sexual contacts or reactions—to the Kinsey one-dimensional scale of sexual orientation. Over 30 years later, Storms (1980) described asexuality using a two-dimensional model of erotic orientation with a focus on the absence of sexual orientation. Despite these early reports, however, little academic attention was given to the topic of asexuality until recent years. The development of the prominent international online community of asexual individuals in 2002, known as the Asexuality and Visibility Education Network (AVEN, http://www.asexuality.org), along with the 2004 publication of Bogaert's large, population-based study, sparked interest in the construct of asexuality from many perspectives (e.g., theoretical, academic, clinical, and feminist perspectives).

As awareness about asexuality has grown, its definition has evolved over time. *Asexuality* has traditionally been defined as an absence of sexual attraction (AVEN, 2002; Bogaert, 2004), but over the last decade, asexuality has come to encompass a larger spectrum of individuals who experience varying levels of sexual and romantic attraction (Hammack et al., 2018). The evolving definition of asexuality, as well as the wide umbrella that captures the diversity of individuals who identify as asexual poses a challenge to establishing the prevalence of asexuality. Bogaert (2004) used a national probability sample of 18,000 British residents and found that 1% of the respondents identified with the statement "I have never felt sexually attracted to anyone at all." Studies have since reported prevalence rates ranging from 1.5% to 3.3%; however, these studies were limited in the age range of participants and therefore not representative samples

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(Höglund et al., 2014; Lucassen et al., 2011). Thus, Bogaert's (2004) prevalence rate of 1% appears to be the most widely cited prevalence estimate of asexuality in the general population, even though current-day estimates suggest that the prevalence of asexuality is likely higher.

Since Bogaert (2004), several studies sought to provide evidence for asexuality as a unique sexual orientation and further characterize asexual persons and their experiences. These were, in part, designed to challenge alternative explanations that engendered societal judgements about asexuality, for example, to oppose the notion that asexuality is a manifestation of psychopathology (Johnson, 1977), that asexuality represents a sexual desire disorder (Childs, 2009; Pagán-Westfall, 2004), or that asexuality is a form of sexual dysfunction or paraphilia (Bogaert, 2006). Studies have explored a myriad of topics, including gender identities of asexual individuals (MacNeela & Murphy, 2015); variations in (a)romantic attractions (Antonsen et al., 2020; Brotto et al., 2010; Ginoza et al., 2014; Zheng & Su, 2018); different sexual experiences, including sexual fantasies (Brotto et al., 2010, 2015; Yule et al., 2014, 2017); mental health correlates of asexuality (Brotto et al., 2010; Yule et al., 2013); and attentional processing of erotic stimuli in asexual individuals (Bradshaw et al., 2021; Brown et al., 2021; Milani et al., 2023). Together, these studies offer insight into the various factors that shape an individual's experience of being "asexual" (Hille, 2022) and provide empirical evidence for recognizing asexuality as a sexual orientation, moving away from a pathological perspective (Brotto & Yule, 2017).

Extant research has established that developmental pathways that are associated with sexual differentiation play an important role in determining sexual orientation. Studies of biomarkers have shown that finger digit ratios (Breedlove, 2010) and height (Skorska & Bogaert, 2017) have been found to be correlated with the development and variation in sexual attractions. Differences in patterns of sexual attraction have also been attributed to differences in prenatal hormone levels—specifically, exposure to androgens such as testosterone (Breedlove, 2017). Prenatal exposure to a high level of androgens results in the development of male physical characteristics, as well as male-typical sexual responses (Holmes et al., 2021). The index–to–ring finger ratio, or "2D:4D" ratio, is the most commonly used biomarker for prenatal androgen exposure, largely due to its early establishment, lifetime stability, and accurate reflection of prenatal androgen exposure (McCarthy, 2016). A lower 2D:4D indicates higher prenatal androgen exposure, whereas a higher 2D:4D ratio corresponds with a low androgen prenatal environment (McCarthy, 2016).

Differences in 2D:4D ratio have commonly been linked to sexual orientation, with multiple studies reporting that lesbian women have lower, or more male-typical, 2D:4D ratios than heterosexual women, indicating higher prenatal exposure to androgens (Breedlove, 2017; Kraemer et al., 2006; Watts et al., 2018). McFadden et al. (2005) found comparable results when comparing homosexual and heterosexual men, with higher 2D:4D ratios observed in men who identified as homosexual. A meta-analysis found the same pattern of results for lesbian women (i.e., lower 2D:4D ratios than heterosexual women) but found no significant difference between homosexual and heterosexual men (Grimbos et al., 2010). In the context of asexuality, a study by Yule et al. (2014) investigated 2D:4D ratios in a sample of 325 asexual people and found no significant differences from a non-asexual group. However, the authors attributed the lack of difference to methodological limitations of internet-based measurements.

Another common biomarker of prenatal development is handedness, which refers to the preferred hand used by an individual for most motor activities (Anderson, 1994). A meta-analysis conducted by Lalumière et al. (2000) revealed a higher incidence of non-right-handedness (i.e., left- or ambiguous-handedness) in non-heterosexual individuals when compared to their heterosexual counterparts, and observed this effect to be greater in women. However, studies over the last two decades have either reported no significant differences in the prevalence of left-handedness among heterosexual and non-heterosexual individuals (Miller et al., 2008; Rahman et al., 2009; Schwartz et al., 2010) or found that non-heterosexuality was related to both left-handedness and extreme right-handedness (Bogaert et al., 2007; Ellis et al., 2017; Kishida & Rahman, 2015). A recent study examining correlates of sexual orientation in Polish men found that gay men were less likely to be left-handed compared to heterosexual men (Folkierska-Żukowska & Dragan, 2024). Whether handedness differs between asexual and non-asexual samples has only been studied in one paper (Yule et al., 2014), in which asexual individuals demonstrated higher rates of non-right-handedness compared to their heterosexual peers. Taken together, the relationship between handedness and sexual orientation appears to be complex and further examination is warranted.

Given that research on biological correlates of homosexuality has been pivotal in advancing our understanding of sexual orientation more broadly, investigating biomarkers of asexuality may similarly strengthen the support for recognizing asexuality as a sexual orientation. Thus, the present study aimed to utilize a large-scale international data set to add to the limited body of literature that explores the potential biological underpinnings of asexuality. The goal of the present study was to investigate group differences between asexual and non-asexual (allosexual) groups on 2D:4D ratios and handedness and how potential group differences may be moderated by sex and, in the case of the digit ratio, the hand used for digit ratio calculations (i.e., left- or right-hand digit ratios). Given that some preliminary findings indicate that digit ratios may differ in left versus right hand and may differ between dominant and non-dominant hand (Manning & Peters, 2009; Nicholls et al., 2008; Richards et al., 2021), both of those aspects were examined in this study.

METHOD

Participants

Participants were recruited through online advertisements (i.e., study flyers titled "Do you identify as asexual, bisexual, gay/lesbian, or heterosexual?") distributed across multiple channels, including the AVEN web discussion board, various social media

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TABLE 1. Sociodemographic Information of Female and Male Participants Who Provided Data

Variable	Female (*n* = 849)	Male (*n* = 822)
Age *M* (*SD*)	27.3 (7.7)	29.9 (10.6)
Sexual Orientation *N* (%)		
Asexual	287 (33.8)	79 (9.6)
Attracted to >1 gender	188 (22.1)	116 (14.1)
Gay/lesbian	64 (7.5)	212 (25.8)
Heterosexual	310 (36.5)	415 (50.5)
Ethnicity *N* (%)		
Arab/West Asian	12 (1.4)	17 (2.1)
Black	36 (4.2)	19 (2.3)
East Asian	92 (10.8)	131 (15.9)
Hispanic	40 (4.7)	52 (6.3)
Indigenous	6 (0.7)	5 (0.6)
Southeast Asian	29 (3.4)	40 (4.9)
South Asian	29 (3.4)	51 (6.2)
White	552 (65.0)	457 (55.6)
Other	43 (5.1)	44 (5.4)
Did not respond	10 (1.2)	6 (0.7)
Level of education *N* (%)		
High School	95 (11.2)	95 (11.6)
Attended some college	255 (30.0)	278 (33.8)
College degree	352 (41.5)	289 (35.2)
Postgraduate degree	139 (16.4)	151 (18.4)
Did not respond	9 (1.1)	8 (1.0)

platforms (i.e., Facebook, Instagram, Reddit, Tumblr etc.), hospital employee mailing lists, paid survey applications, and university paid-study portals. Recruitment also involved distributing study flyers in community spaces (i.e., coffee shops, university bulletins), as well as placing advertisements on public transit (i.e., city buses and SkyTrain). Individuals self-identifying as asexual or allosexual were considered eligible if they were 19 years or older (age of majority in the province in which the study was conducted) and were fluent in the English language.

A total of 2,085 individuals expressed interest in the study, of whom one individual did not meet the eligibility criteria (i.e., not fluent in English), and three individuals did not provide consent upon receiving the questionnaire package and therefore did not participate in the study. In total, 2,081 individuals started the questionnaire, with 1,979 completing the questionnaire package. The final sample used for at least one of the analyses consisted of 1,671 participants (female = 849, male = 822). Demographic information for included participants is presented in Table 1.

Measures

Demographics, Sexual Orientation, and Participant Sex

Study demographics were assessed through questions about age, sexual orientation, ethnicity, education level, gender identity, and sex assigned at birth. Participants' sexual orientation was assessed multiple times throughout the study. Sexual orientation was assessed initially in the eligibility telephone screening and later confirmed on the first page of the questionnaire package. During the telephone screening, participants were asked, "Which of the following best describes your sexual orientation?" and were provided with the following response options: asexual, bisexual (including pansexual), lesbian/gay, and heterosexual. Sexual orientation was also assessed in different formats (i.e., multiple choice, open-ended question) as part of the demographic questionnaire as well as the Asexuality Identification Scale (AIS). Sexual orientation responses were consistent across multiple questions, thus ensuring reliability. Discrepancies in responses were only identified for individuals who chose to provide further details about their sexual orientation. For example, approximately 10% of asexual participants used open-ended questions to describe their sexual orientation as "demisexual" and "gray-ace," among others. Answers provided during the telephone screening served as the source for the sexual orientation variable in the current analyses. Participants were additionally asked separate questions about their current gender identity, sex, and whether they had trans experience. Given that 2D:4D digit ratio is a factor with a largely biological basis (Manning & Fink, 2018), only participants' whose current gender identity was aligned with their sex (i.e., cisgender individuals) were included in the analyses to maximize the probability of correct sex assignment (294 were excluded due to incomplete participant gender/sex information and/or non-cisgender identities).

Asexual Identity

In addition to the option of self-identifying categorically as asexual, participants' level of asexuality was assessed continuously. The AIS (Yule et al., 2015) is a 12-item self-report tool that provides a valid and reliable measure of asexual identity. Each item is rated on a 5-point scale ranging from 1 (*completely false/never*) to 5 (*completely true/always*) and is based on participants' lifetime experiences. A cumulative AIS score was then calculated for each participant, with scores ranging between 12 and 60. According to Yule et al. (2015), individuals with a score of 40 or higher are more likely to experience a lack of sexual attraction; therefore, this cut-off score allows for categorization of asexual and allosexual participants. The AIS demonstrated good internal consistency in previous samples and the ability to discriminate between sexual and asexual individuals (Yule et al., 2015). Cronbach's alpha for the present sample was .967.

2D:4D Finger Digit Ratio

To collect 2D:4D digit ratio data, participants were instructed to provide two photographs: one of their left hand and one of their right hand, which were uploaded online as part of the questionnaire package. Detailed instructions were provided to guide participants in taking the photographs with each respective hand on a flat surface, with their palms facing up and fingers outstretched. The instructions also asked participants to remove jewellery (i.e., rings) prior to taking the photograph and suggested that participants use their device's flash if their surroundings were too dim. Additionally, the page with these instructions consisted of two "Upload Document" tabs, which allowed participants to upload

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a photograph of each hand separately, as well as corresponding "Remove File" tabs to permit retakes. Examples of incorrectly and correctly taken photographs were provided as well, to further ensure that participants understood the instructions and uploaded images that were acceptable.

Vector graphic software Inkscape was used to measure index (2D) and ring (4D) finger length and subsequently determine each participant's left- and right-hand 2D:4D digit ratios. The dimensions of each picture were first standardized to be 1600.08 × 2192.95 pixels. Once standardized, a straight line from the base of the finger to the tip was created using Inkscape, and the software measured this path length in centimetres and pixels. Two independent raters completed the measurements for each data point, and the average of each measurement was then calculated and used for analysis. The intraclass correlation coefficient (ICC) was calculated, and our results indicated good inter-rater reliability: the ICC was 0.86 (95% CI [0.83, 0.91]) for the left-hand digit ratios and 0.92 (95% CI [0.89, 0.94]) for the right-hand digit ratios.

Handedness

The Edinburgh Handedness Inventory (EHI; Oldfield, 1971) is one of the most widely used tools to assess handedness (Bishop et al., 1996), which refers to the dominant hand (right-handed or non-right-handed) used by individuals in most day-to-day activities. The EHI has been validated and evaluated for reliability across several populations and has demonstrated high internal consistency (Cronbach's $\alpha \approx .80–.95$) and strong test-retest reliability (e.g., Dragovic, 2004; Ransil & Schachter, 1994). The EHI has 10 items describing everyday actions (e.g., writing, drawing), to which participants responded by indicating the hand they prefer to use during these activities with a plus symbol (+). If the other hand would never be used for an activity, the preferred hand was scored with two plus symbols (++). A lack of preference was indicated by a plus symbol for both the left and right hand. An EHI score was then calculated by dividing the difference between left- and right-hand responses (a "difference" score) by the sum of left- and right-hand responses (a "cumulative" score). This measure can be used as a continuous variable (higher score indicates more right-handedness) or serve as a basis for categorizing people's handedness. A score less than or equal to −40 indicated left-handedness, while a score greater than or equal to 40 indicated right-handedness. Ambidextrousness, or a lack of preference, was indicated by a score between −40 and 40. In this study, in addition to using their continuous handedness score, participants were dichotomized into right-handed (equal to or greater than 40) and non-right-handed (less than 40) for the digit ratio analysis.

Procedure

Interested participants were required to contact the study coordinator directly via email. Their eligibility was then assessed through a scheduled telephone screening call, during which they were also informed about the study's procedures. Eligible participants were provided with a questionnaire package through an individualized link to an online survey (Qualtrics). Prior to commencing the questionnaire package, informed consent was obtained from participants, indicating that they had read and understood the consent form and agreed to participate in the study. Additionally, two questions confirming the participant's age and sexual orientation were posed to ensure that participants met the age inclusion criteria and to verify their sexual orientation.

Participants were not required to answer any questions that they did not feel comfortable answering. The battery included a demographic questionnaire, the AIS (Yule et al., 2015), the EHI (Oldfield, 1971), and additional sexuality measures that were not analyzed as part of the current article; the battery took approximately 40 minutes to complete. Additionally, participants were provided with detailed instructions on how to provide two photographs, one of their left hand and one of their right hand. These instructions informed participants to take the pictures with each hand on a flat surface, with their palms up and fingers outstretched, and advised that all jewellery was removed prior to taking the pictures. These pictures were then used to measure the left- and right-hand 2D:4D digit ratio for each participant.

If an individual did not complete the questionnaire package 3 weeks after receiving a personalized link, a follow-up email was sent to the email address provided. This email was sent to discover if participants had any remaining questions and/or concerns, as well as determine if they were still interested in participating in the study. If an individual opted out of the study, they were not required to provide a reason. A total of 106 dropped out of the study and did not complete all aspects of the questionnaire package.

At the end of the questionnaire, participants were provided with a thorough written debriefing. Participants who resided in Canada, the United States, Australia, Hong Kong, Ireland, Mexico, or the United Kingdom at the time of completion received an electronic Starbucks gift card equivalent to CAN$10 in their respective currencies. These were processed by the study coordinator. Participants not residing in one of these countries were reimbursed with a CAN$10 prepaid Visa gift card, converted to the equivalent amount in their local currency. These gift cards were accessed through BHN Rewards (http://www.rybbon.net/), and participants' first names and email addresses were required to process the reimbursement; however, this information was not linked to study identification data. The study was approved by the Behavioural Research Ethics Board at the University of British Columbia and funded by a research grant from the Natural Sciences and Engineering Council of Canada Discovery Grant to the senior author.

Data Analysis

Regarding handedness, we used a 2 × 4 analysis of variance (ANOVA) with two independent variables, a two-level sex at birth variable (female and male), and a four-level sexual orientation variable (asexual, those attracted to more than one gender, gay/lesbian, and heterosexual) to compare participants on the continuous EHI score. In terms of digit ratio, we examined differences in left- and right-hand digit ratios between the four

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sexual orientation groups. Two between-subject factors were also included in the analyses: sex at birth (female and male) and handedness (right-hand dominant and non-right-hand dominant). Digit ratio was a within-subject variable with two levels (digit ratio measured on the left hand and digit ratio measured on the right hand for each participant). A mixed effects 4 × 2 × 2 × 2 ANOVA was conducted with these three between-subject factors and one within-subject factor. All main effects, two-way interactions, three-way interactions, and the four-way interaction were tested. All significant effects were further investigated with post hoc tests.

A power analysis was conducted using G*power (Faul et al., 2007) to determine the required sample size for detecting a within-between interaction in a 4 × 2 × 2 × 2 mixed-design ANOVA. To detect a medium effect size (f = .25) at an alpha level of .05 with power of 0.80, the required total sample size was 96 participants. However, our sample is considerably larger because this study is a part of a larger project that also included a study testing sibship effects among different sexual orientations, including asexuality, and those analyses required larger samples (power analysis for that study is described in Zdaniuk et al., 2025).

RESULTS

The AIS scores for each of the four sexual orientation groups were as follows: asexual (M = 48.98, SD = 8.66), attracted to more than one gender (M = 20.48, SD = 7.74), gay/lesbian (M = 18.62, SD = 6.57), and heterosexual (M = 18.34, SD = 6.68). Significant between-group differences for total AIS scores were observed, $F(3, 2048) = 2121.49$, $p < .001$, $\eta^2 = .76$, such that asexual participants had significantly higher AIS scores than the other three groups ($ps < .001$). Post hoc comparisons also revealed that those attracted to more than one gender had significantly higher AIS scores than gay/lesbian participants (p = .005) and heterosexual participants ($p < .001$).

Regarding digit ratio, the analysis revealed a significant main effect of sex at birth on digit ratio, $F(1,1520) = 19.66$, $p < .001$, $\eta^2 = .013$. Females had a higher left-hand digit ratio (M = 1.000) and right-hand digit ratio (M = 1.002) than males (left-hand mean = .984, right-hand mean = .987). No significant main effects of sexual orientation (p = .067) or handedness (p = .085) on digit ratio were observed.

A significant two-way interaction was found between sexual orientation and the hand used for digit ratio calculations, $F(3,1520) = 4.92$, $p = .002$, $\eta^2 = .010$. Specifically, gay/lesbian participants had a significantly higher left-hand digit ratio than asexual participants ($p < .001$), heterosexual participants (p = .003), and those attracted to more than one gender (p = .029). However, the only difference observed for right-hand digit ratios was between asexual participants and those attracted to more than one gender (p = .042), with asexual participants having a lower digit ratio.

Additionally, a significant interaction between handedness and sexual orientation was observed, $F(3, 1520) = 2.95$, $p = .032$, $\eta^2 = .006$. Post hoc comparisons indicated that, for non-right-handed people, asexual participants had a lower digit ratio (averaged across both hands) than gay/lesbian participants (p = .008), heterosexual participants (p = .008), and those attracted to more than one gender (p = .027). There were no significant differences observed between the sexual orientation groups for right-handed individuals ($ps > .081$). None of the other two-way interactions were significant.

The two significant two-way interactions were further qualified by the three-way interaction (see Figure 1) between sexual orientation, handedness, and the hand used for digit ratio calculations, $F(3,1520) = 3.52$, $p = .015$, $\eta^2 = .007$. As shown in Table 2, the only difference in right-hand digit ratio between groups was observed for non-right-handed asexual participants and those attracted to more than one gender (p = .017), with asexual participants having a lower right-hand digit ratio. For left-hand digit ratios, both right-handed and non-right-handed groups displayed significant differences in left-hand digit ratio across sexual orientation groups. Right-handed heterosexual participants were observed to have a lower left-hand digit ratio than gay/lesbian participants (p = .008) and those attracted to more than one gender (p = .005). Additionally, non-right-handed asexual participants had a significantly lower left-hand digit ratio than heterosexual (p = .007) and gay/lesbian participants ($p < .001$). None of the other three-way interactions were significant. The four-way interaction between sex at birth, sexual orientation, handedness, and the hand used for digit ratio calculations was not significant (p = .657).

Regarding handedness, the analysis did not reveal a significant sex at birth by sexual orientation interaction, $F(3,1644) = 0.38$, $p = .766$, $\eta^2 = .001$; no significant main effect of sex, $F(1, 1644) = 3.84$, $p = .050$, $\eta^2 = .002$); and no significant main effect of sexual orientation, $F(1, 1644) = 2.19$, $p = .087$, $\eta^2 = .004$. Group means are presented in Table 3. Even though the overall F-test did not reach statistical significance, the sizable mean differences between asexual males and males from other sexual orientations prompted us to conduct a follow-up analysis in which asexual participants were compared to allosexual participants (the heterosexual, gay/lesbian, and those attracted to more than one gender groups combined). Simple effects of that comparison tested within female and male groups indicated a significant effect for males, with asexual males scoring lower at M = 49.4 on EHI measure than allosexual males at M = 61.0, $F(1,1648) = 4.30$, $p = .038$, $\eta^2 = .003$, but not for females, M = 59.8 and 64.2, for asexual and allosexual females, respectively, $F(1,1648) = 1.63$, $p = .201$, $\eta^2 = .001$.

DISCUSSION

Summary of Findings

The present study used biomarkers (digit ratios and handedness) that have been previously shown to be related to sexual orientation to investigate group differences among females and males who identified as asexual, those attracted to more than 1 gender, gay/lesbian, and heterosexual respondents. Responses to a validated measure of asexuality (the AIS) provided support for the categorization of our sample as asexual. Regarding sex

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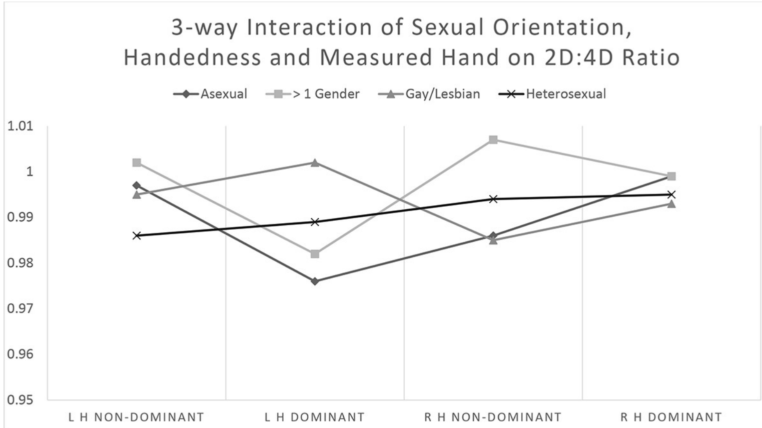

FIGURE 1. Non-right-handed asexual participants had a lower right-hand digit ratio than those attracted to more than one gender and a lower left-hand digit ratio than gay/lesbian and heterosexual participants. Right-handed heterosexual participants had a lower left-hand digit ratio than gay/lesbian participants and those attracted to more than one gender. L H = left hand; R H = right hand.

TABLE 2. Marginal Means of 2D:4D Digit Ratios, Separated by Handedness and Sexual Orientation

	Right-handed participants			Non-right-handed participants			All participants	
	1	2		3	4			
	Left-hand ratio	Right-hand ratio	Average ratio	Left-hand ratio	Right-hand ratio	Average ratio	Average left-hand ratio	Average right-hand ratio
Asexual	.997^{ab}	.999^{a}	.996^{a}	.976^{a}	.986^{a}	.974^{a}	0.982^{a}	0.989^{a}
Attracted to >1 Gender	1.002^{b}	.999^{a}	.998^{a}	.982^{ac}	1.007^{b}	.993^{b}	0.991^{a}	1.001^{b}
Gay/Lesbian	.995^{a}	.993^{a}	.997^{a}	1.002^{b}	.985	.999^{b}	1.005^{b}	0.991^{ab}
Heterosexual	.986^{a}	.995^{a}	.992^{a}	.989^{bc}	.994	.993^{b}	0.989^{a}	0.995^{ab}

Note. All post hoc comparisons tested differences between sexual orientation groups. "Average ratio" columns present post hoc comparisons for the two-way interaction effect between handedness and sexual orientation. The last two columns (average left-hand and average right-hand ratio columns) present post hoc comparisons for the two-way interaction effect between measured hand and sexual orientation. Columns 1, 2, 3, and 4 present post hoc comparisons for the three-way interaction effect between handedness, hand measured (left or right digit ratio), and sexual orientation. Means with no common letter superscripts (a, b, c) are significantly different at $p < .05$.

TABLE 3. Handedness Scores by Sex Assigned at Birth and Sexual Orientation

	Female (*n* = 834)		Male (*n* = 804)		Total (*n* = 1638)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Asexual	59.83	49.30	49.36	58.61	57.54	51.57
Attracted to >1 Gender	62.40	42.88	59.39	48.79	61.28	45.11
Gay/Lesbian	65.78	48.48	60.51	47.27	61.74	47.52
Heterosexual	65.03	44.87	61.66	47.11	63.11	46.16

Note. Handedness assessed with the Edinburgh Handedness Inventory. Data represent means and standard deviations.

differences, our results revealed that regardless of sexual orientation, female participants had higher digit ratios than males on both hands. Participant sex, however, did not significantly affect any of the other results. Although examining handedness as a continuous outcome yielded no differences across the four sexual orientation groups, follow-up analyses revealed a non-right-handedness effect for asexual male participants relative to allosexual males. We also found some complex associations between sexual orientation, dichotomized handedness, and the measured hand on digit ratios. We observed that gay/lesbian participants had higher left-hand digit ratios relative to the other three sexual orientation groups. We also found that right-handed heterosexual participants had lower left-hand digit ratios than gay/lesbian participants and those attracted to more than one gender. With respect to asexual participants, non-right-handed asexuals had lower left- and right-hand digit ratios relative to the other three sexual orientation groups. Specifically, non-right-handed asexual participants had lower right-hand digit ratios than those attracted to more than one gender and lower left-hand digit ratios compared to gay/lesbian and heterosexual participants.

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Digit Ratio Findings

The current results that females had higher left- and right-hand digit ratios than males, with a medium effect size, supported previous findings that have shown a robust sex difference in digit ratios (Breedlove, 2017; McCarthy, 2016; Williams et al., 2000). It is theorized that prenatal androgen levels are involved in the masculinization of physical traits until a critical threshold is reached, at which time the same traits are feminized (Lippa, 2003). Indeed, our findings indicated that in females, the length of the index finger is almost the same as the ring finger, resulting in a 2D:4D ratio of approximately 1.00. In males, the index finger is shorter than the ring finger, resulting in a 2D:4D ratio that is less than 1.00. Our finding is thus consistent with the existing body of literature on the topic and further highlights the use of biological factors, such as birth-assigned sex, when examining the potential effects of biomarkers. Although our study was intentionally inclusive of both sex and gender, and in particular diverse gender identities, we examined participant sex as an independent variable given its relevance to our study aims. Beyond this main finding (of significant sex differences in digit ratios), sex did not impact any of the other findings and highlights the importance of considering other facets of participants' identities, beyond their birth-assigned sex.

Regarding our findings on sexual orientation and digit ratios, the present findings suggest a complex relationship that requires the consideration of the hand used to calculate digit ratios, as well as the participant's handedness (i.e., right-handed vs. non-right-handed). Our findings showed that gay/lesbian participants had higher left-hand digit ratios relative to participants in the other three sexual orientation groups. This finding is partially supported by some research showing that gay men tend to exhibit higher digit ratios (suggesting a lower prenatal androgen exposure) than heterosexual men in utero (McFadden et al., 2005). Interestingly, our findings for lesbian women did not align with the robust existing literature, which shows that lesbian women tend to have lower digit ratios (i.e., higher prenatal androgen exposure) than their heterosexual counterparts (Breedlove, 2017; Grimbos et al., 2010; Kraemer et al., 2006). It is possible that the larger gay male sample in the current study (n = 212), relative to the smaller lesbian sample (n = 64), is yielding this effect of digit ratio patterns that tend to be associated with lower prenatal androgen levels. Also, somewhat inconsistent with the literature, we found that right-handed heterosexual participants had lower left-hand digit ratios relative to participants who identified as gay/lesbian and those attracted to more than one gender. This finding contradicts existing support for the theory that exposure to higher levels of prenatal androgens is associated with left-handedness and lower digit ratios (Seddon & McManus, 1993). That we found an association between right-handedness and lower left-hand digit ratios indicates the potential importance of examining handedness together with the hand used for digit ratios, given the potential interplay of these factors. It may also provide evidence for a potential association between gender (non-)conformity and biomarkers. A previous study found that the profile consisting of the most masculine 2D:4D ratios (i.e., lower digit ratios) was also the most gender-conforming and predominantly heterosexual profile in a sample of men (Folkierska-Żukowska & Dragan, 2024). Although the aforementioned study examined differences in gay and heterosexual men, the findings may provide an explanation, at least in part, for the current findings. More specifically, it is well established that across both females and males, individuals who identify as heterosexual are more gender-conforming than those with diverse sexual orientations (Lippa, 2005; Rieger & Savin-Williams, 2012). Thus, that heterosexual participants in our sample (relative to gay/lesbian participants and those attracted to more than one gender) exhibited more masculine-associated 2D:4D ratios aligns with the predominantly heterosexual, gender-conforming profile. It is important to take note that these findings were only observed for left-hand digit ratios. This does not align with meta-analyses that have suggested that right-hand 2D:4D ratios may be a better biomarker than left-hand digit ratios (Hönekopp & Watson, 2010; Richards et al., 2020). Together, our findings highlight the importance of examining digit ratios in both hands as they may yield different results. Also, future studies should more closely examine the specific role that the dominant hand plays in differences observed for digit ratios, given the nuance in the findings.

Regarding asexuality, we also found interactions between the hand used for digit ratio calculations and handedness, suggesting the nuance in interpreting the findings. The only other study examining digit ratios in a sample of asexual participants reported no significant differences in digit ratios between asexual and allosexual participants (Yule et al., 2014). The present study, however, found that non-right-handed asexual participants had lower left- and right-hand digit ratios than the other three sexual orientation groups. More specifically, non-right-handed asexual participants had lower right-hand digit ratios than those attracted to more than one gender, and lower left-hand digit ratios than participants who identified as gay/lesbian or heterosexual. The potential association observed between non-right-handedness and lower digit ratios in asexual participants may suggest higher prenatal androgen exposure in some asexual individuals. These results are intriguing, albeit unexpected, as they imply that the most masculinized individuals in this sample belong to a subgroup of asexuals, and they do not align with existing associations that have been found between non-heterosexuality, gender nonconformity, prenatal androgen exposure, and non-right-handedness. For example, there is strong evidence that prenatal androgen levels influence gender-related behaviours, with higher exposure reinforcing gender-typical behaviours and lower prenatal exposure increasing gender nonconformity (Auyeung et al., 2009; Swift-Gallant et al., 2022). Non-heterosexual individuals (e.g., bisexual, gay, and lesbian) tend to exhibit higher levels of gender nonconformity both during childhood and adulthood (Bailey & Zucker, 1995; Li et al., 2017; Rieger et al., 2008), and others have similarly noted a higher proportion of gender nonconformity among asexual populations (Gupta, 2019; Miller, 2012). Thus, given the previously noted established patterns that have been observed for non-heterosexual individuals, we would have expected to find higher digit ratios and lower prenatal androgen

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exposure in asexual participants. We are uncertain as to why higher prenatal masculinization (i.e., lower digit ratios) would be associated with asexuality. It may be that including only cisgender individuals in our analyses may have impacted these results, given that the proportion of asexual participants who were gender-nonconforming was excluded: Approximately one quarter of our asexual sample indicated gender identities beyond the binary. Nonetheless, our findings highlight the complex interplay of biological, environmental, and social factors in shaping sexual orientation, and further research is warranted to explore the interplay of these factors.

Handedness Findings

That we found no significant differences in handedness across participant sex or sexual orientation corroborated some existing research (e.g., Miller et al., 2008; Rahman et al., 2009; Schwartz et al., 2010) but contradicted others (Bogaert et al., 2007; Ellis et al., 2017; Folkierska-Żukowska & Dragan, 2024; Kishida & Rahman, 2015; Swift-Gallant et al., 2017). Regarding asexuality, Yule et al. (2014) found that men and women who identified as asexual were more likely to display non-right-handedness than their heterosexual counterparts, and our results partially confirmed this finding when comparing asexual males to allosexual males (the three non-asexual groups combined) but not for females. The most parsimonious explanation for these mixed results may be that handedness is influenced by genetic factors and thus may not directly involve prenatal androgen levels (Davies & Wilkinson, 2006; Klar, 2003; Rife, 1940). That is, the specific mechanisms involved in the development of handedness and how those mechanisms play a role in the development of sexual orientation remain unknown. It also could be that in addition to the influence of prenatal androgen levels, other factors that have an effect on handedness development may play a role in sexual orientation. It has been theorized that several critical periods of exposure to androgen levels (i.e., surges and declines in prenatal androgen levels) that influence physical traits, as well as individual differences in how androgen is utilized may account for variations in sexual orientation to varying degrees (e.g., Bogaert & Hershberger, 1999; McFadden, 2002). Lalumière et al. (2000) also argued that disruptive events that cause developmental instability (e.g., pathogens, pollutants, and stress during pregnancy) may modify sexual differentiation of the brain and affect sexual orientation. Such factors were not examined in the current study; thus, investigating the role of other factors (i.e., developmental instability) and their links to sexual orientation is a fruitful avenue for future research.

Of note, there is some evidence of non-linear patterns for the association between handedness and sexual orientation. Assessing sexual orientation on a continuum of sexual attraction—such that participants indicated how sexually attracted they were to males and females, separately, on a scale of 0 to 10 (0, *not at all*, and 10, *the most extreme degree*)—Ellis and colleagues (2017) found that males and females who were ambidextrous (and right-handed most of the time) were least likely to be exclusively heterosexual and most likely to be exclusively homosexual. Those who had more extreme right-handedness and more extreme left-handedness were more prone toward heterosexuality, particularly among males. Interestingly, and to complicate matters further, the relationship between handedness and homosexuality was null after controlling for ethnicity. Nonetheless, the Ellis et al. (2017) study highlighted some important points for consideration. In the current study, we used a continuous measure of handedness rather than a categorical measure such as the one Ellis et al. utilized (i.e., left-handed almost always, left-handed most of the time, either hand almost equally, right-handed most of the time, right-handed almost always). This may help explain, at least in part, our different findings regarding handedness and sexual orientation. Also, perhaps utilizing a more nuanced measure to examine sexual attractions on a continuum, such as the degree of androphilia and the degree of gynephilia rather than broad sexual orientation categories, may yield a more accurate picture of the relationship between handedness and sexual orientation.

Evolving Definition of Asexuality

Indeed, the definition of asexuality has evolved over the last decade and encompasses a broader range of experiences and identities. Similar to other sexual orientation groups, asexual individuals are a heterogeneous group; as such, variations may exist in the biological (and likely also social) processes that influence the development of sexual orientation. Different factors may be involved to varying degrees across individuals who identify as asexual. For instance, Swift-Gallant et al. (2021) found differences in digit ratios within a group of gay men such that those who typically adopted the “top” sexual role had more male-typical digit ratios (i.e., lower digit ratios) and those who typically adopted the “bottom” role had more feminized (i.e., higher digit ratios). In the current study, we adopted a broad definition of asexuality (e.g., our sample included individuals who identified as gray-ace, demisexual, aromantic asexual, etc.), and that may explain why our results contradicted earlier research on biomarkers and asexuality, where the asexual participants may have been a more homogeneous group. As experiences related to (a)sexuality continue to evolve, further research is necessary. Given the established associations and intricate relationships between sexual orientation, gender identity, and biological markers, future research would benefit from a more comprehensive approach to examining these factors. Exploring within-group variations in sexual attraction and orientation and their potential connections to different biomarkers is warranted.

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REFERENCES

Anderson, R. M. (1994). Handedness. In *Practitioner's guide to clinical neuropsychology: Critical issues in neuropsychology* (pp. 23–25). Springer. https://doi.org/10.1007/978-1-4615-2480-9_7

Antonsen, A. N., Zdaniuk, B., Yule, M., & Brotto, L. A. (2020). Ace and aro: Understanding differences in romantic attractions among persons identifying as asexual. *Archives of Sexual Behavior*, *49*(5), 1615–1630. https://doi.org/10.1007/s10508-019-01600-1

Asexuality and Visibility Education Network. (2022). Retrieved from https://www.asexuality.org/

Auyeung, B., Baron-Cohen, S., Ashwin, E., Knickmeyer, R., Taylor, K., Hackett, G., & Hines, M. (2009). Fetal testosterone predicts sexually differentiated childhood behavior in girls and in boys. *Psychological Science*, *20*(2), 144–148. https://doi.org/10.1111/j.1467-9280.2009.02279.x

Bailey, J. M., & Zucker, K. J. (1995). Childhood sex-typed behavior and sexual orientation: A conceptual analysis and quantitative review. *Developmental Psychology*, *31*(1), 43–55. https://doi.org/10.1037/0012-1649.31.1.43

Bishop, D. V. M., Ross, V. A., Daniels, M. S., & Bright, P. (1996). The measurement of hand preference: A validation study comparing three groups of right-handers. *The British Journal of Psychology*, *87*(2), 269–285. https://doi.org/10.1111/j.2044-8295.1996.tb02590.x

Bogaert, A. F. (2004). Asexuality: Prevalence and associated factors in a national probability sample. *Journal of Sex Research*, *41*(3), 279–287. https://doi.org/10.1080/00224490409552235

Bogaert, A. F. (2006). Toward a conceptual understanding of asexuality. *Review of General Psychology*,*10*(3), 241–250. https://doi.org/10.1037/1089-2680.10.3.241

Bogaert, A. F., Blanchard, R., & Crosthwait, L. E. (2007). Interaction of birth order, handedness, and sexual orientation in the Kinsey interview data. *Behavioral Neuroscience*, *121*, 845–853. https://doi.org/10.1037/0735-7044.121.5.845

Bogaert, A., & Hershberger, S. (1999). The relation between sexual orientation and penile size. *Archives of Sexual Behavior*, *28*(3), 213–221. https://doi.org/10.1023/A:1018780108597

Bradshaw, J., Brown, N., Kingstone, A., & Brotto, L. (2021). Asexuality vs. sexual interest/arousal disorder: Examining group differences in initial attention to sexual stimuli. *PLoS ONE*, *16*(12), e0261434. https://doi.org/10.1371/journal.pone.0261434

Breedlove, S. M. (2010). Minireview: Organizational hypothesis: Instances of the fingerpost. *Endocrinology*, *151*(9), 4116–4122. https://doi.org/10.1210/en.2010-0041

Breedlove, S. M. (2017). Prenatal influences on human sexual orientation: Expectations versus data. *Archives of Sexual Behavior*, *46*(6), 1583–1592. https://doi.org/10.1007/s10508-016-0904-2

Brotto, L. A., Knudson, G., Inskip, J., Rhodes, K., & Erskine, Y. (2010). Asexuality: A mixed-methods approach. *Archives of Sexual Behavior*, *39*(3), 599–618. https://doi.org/10.1007/s10508-008-9434-x

Brotto, L. A., & Yule, M. A. (2017). Asexuality: Sexual orientation, paraphilia, sexual dysfunction, or none of the above? *Archives of Sexual Behavior*, *46*(3), 619–627. https://doi.org/10.1007/s10508-016-0802-7

Brotto, L. A., Yule, M. A., & Gorzalka, B. B. (2015). Asexuality: An extreme variant of sexual desire disorder? *Journal of Sexual Medicine*, *12*(3), 646–660. https://doi.org/10.1111/jsm.12806

Brown, N. B., Peragine, D., VanderLaan, D. P., Kingstone, A., & Brotto, L.A. (2021). Cognitive processing of sexual cues in asexual individuals and heterosexual women with desire/arousal difficulties. *PLOS ONE*, *15*(5), e0251074. https://doi.org/10.1371/journal.pone.0251074

Childs, D. (2009, January 16). Asexuals push for greater recognition. *ABC News*. http://abcnews.go.com/Health/MindMoodNews/asexuals-push-greater-recognition/story?id=6656358

Davies, W., & Wilkinson, L. S. (2006). It is not all hormones: Alternative explanations for sexual differentiation of the brain. *Brain Research*, 1126(1), 36–45. https://doi.org/10.1016/j.brainres.2006.09.105

Dragovic, M. (2004). Towards an improved measure of the Edinburgh handedness inventory: A one-factor congeneric measurement model using confirmatory factor analysis. *Laterality (Hove)*, *9*(4), 411–419. https://doi.org/10.1080/13576500342000248

Ellis, L., Skorska, M. N., & Bogaert, A. F. (2017) Handedness, sexual orientation, and somatic markers for prenatal androgens: Are southpaws really that gay? *Laterality: Asymmetries of Body, Brain and Cognition*, 22(2), 157–180. https://doi.org/10.1080/1357650X.2016.1151024

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191.

Folkierska-Żukowska, M., & Dragan, W. L. (2024). Biodevelopmental correlates of sexual orientation in men: Evidence from a polish sample. *Archives of Sexual Behavior*. Advanced online publication. https://doi.org/10.1007/s10508-024-03018-w

Ginoza, M. K., Miller, T., & AVEN Survey Team. (2014, November 1). *The 2014 AVEN community census: Preliminary findings*. AVEN. https://asexualcensus.files.wordpress.com/2014/11/2014censuspreliminaryreport.pdf

Grimbos, T., Dawood, K., Burriss, R. P., Zucker, K. J., & Puts, D. A. (2010). Sexual orientation and the second to fourth finger length ratio: A meta-analysis in men and women. *Behavioral Neuroscience*, *124*(2), 278–287. https://doi.org/10.1037/a0018764

Gupta, K. (2019). Gendering asexuality and asexualizing gender: A qualitative study exploring the intersections between gender

© Sex Information and Education Council of Canada, 2025

and asexuality. *Sexualities*, *22*(7–8), 1197–1216. https://doi.org/10.1177/1363460718790890

Hammack, P. L., Frost, D. M., & Hughes, S. D. (2018). Queer intimacies: A new paradigm for the study of relationship diversity. *The Journal of Sex Research*, *56*(4–5), 556–592. https://doi.org/10.1080/00224499.2018.1531281

Hille, J. J. (2022). Beyond sex: A review of recent literature on asexuality. *Current Opinion in Psychology*, *49*, 101516–101516. https://doi.org/10.1016/j.copsyc.2022.101516

Höglund, J., Jern, P., Sandnabba, N. K., & Santtila, P. (2014). Finnish women and men who self-report no sexual attraction in the past 12 months: Prevalence, relationship status, and sexual behavior history. *Archives of Sexual Behavior*, *43*(5), 879–889. https://doi.org/10.1007/s10508-013-0240-8

Holmes, L., Watts-Overall, T. M., Slettevold, E., Gruia, D. C., & Rieger, G. (2021). Sex differences in sexual arousal and finger length ratio. *The Journal of Sex Research*, *59*(4), 1–9. https://doi.org/10.1080/00224499.2021.1874262

Hönekopp, J., & Watson, S. (2010). Meta-analysis of digit ratio 2D:4D shows greater sex difference in the right hand. *American Journal of Human Biology*, *22*(5), 619–630. https://doi.org/10.1002/ajhb.21054

Johnson, M. T. (1977). Asexual and autoerotic women: Two invisible groups. In H. L. Gochros & J. S. Gochros (Eds.), *The sexually oppressed* (pp. 96– 109). Association Press.

Kinsey, A. C., Pomeroy, W. B., & Martin, C. E. (1948). *Sexual behavior in the human male*. Saunders.

Kishida, M., & Rahman, Q. (2015). Fraternal birth order and extreme right-handedness as predictors of sexual orientation and gender nonconformity in men. *Archives of Sexual Behavior*, *44*(5), 1493–1501. https://doi.org/10.1007/s10508-014-0474-0

Klar A. J. (2003). Human handedness and scalp hair-whorl direction develop from a common genetic mechanism. *Genetics*, *165*(1), 269–276. https://doi-org.ezproxy.library.ubc.ca/10.1093/genetics/165.1.269

Kraemer, B., Noll, T., Delsignore, A., Milos, G., Schnyder, U., & Hepp, U. (2006). Finger length ratio (2D: 4D) and dimensions of sexual orientation. *Neuropsychobiology*, 53, 210–214. https://doi.org/10.1159/000094730

Lalumière, M. L., Blanchard, R., & Zucker, K. J. (2000). Sexual orientation and handedness in men and women: A meta-analysis. *Psychological Bulletin*, *126*(4), 575–592. https://doi.org/10.1037/0033-2909.126.4.575

Li, G., Kung, K. T. F. & Hines, M. (2017). Childhood gender-typed behavior and adolescent sexual orientation: A longitudinal population-based study. *Developmental Psychology*, *53*(4), 764–777. https://doi.org/10.1037/dev0000281

Lippa, R. A. (2003). Handedness, sexual orientation, and gender-related personality traits in men and women. *Archives of Sexual Behavior*, *32*(2), 103–114. https://doi.org/10.1023/A:1022444223812

Lippa, R. A. (2005). Sexual orientation and personality. *Annual Review of Sex Research*, *16*, 119–153.

Lucassen, M. F. G., Merry, S. N., Robinson, E. M., Denny, S., Clark, T., Ameratunga, S., Crengle, S., & Rossen, F. V. (2011). Sexual attraction, depression, self-harm, suicidality and help-seeking behavior in New Zealand secondary school students. *Australian and New Zealand Journal of Psychiatry*, *45*(5), 376–383. https://doi.org/10.3109/00048674.2011.559635

MacNeela, P., & Murphy, A. (2015). Freedom, invisibility, and community: A qualitative study of self-identification with asexuality. *Archives of Sexual Behavior*, *44*(3), 799–812. https://doi.org/10.1007/s10508-014-0458-0

Manning, J. T., & Fink, B. (2018). Sexual dimorphism in the ontogeny of second (2D) and fourth (4D) digit lengths, and digit ratio (2D:4D). *American Journal of Human Biology*, *30*(4), e23138. https://doi.org/10.1002/ajhb.23138

Manning, J. T., & Peters, M. (2009). Digit ratio (2D:4D) and hand preference for writing in the BBC internet study. *Laterality (Hove)*, *14*(5), 528–540. https://doi.org/10.1080/13576500802637872

McCarthy, M. (2016). Strategies and approaches for studying sex differences in physiology. In G. N. Neigh & M. M.. Mitzelfelt (Eds.), *Sex differences in physiology* (pp. 181–220). Academic Press. https://doi.org/10.1016/b978-0-12-802388-4.00011-2

McFadden, D. (2002). Masculinization effects in the auditory system. *Archives of Sexual Behavior*, *31*(1), 99–111. https://doi.org/10.1023/A:1014087319682

McFadden, D., Loehlin, J. C., Breedlove, S. M., Lippa, R. A., Manning, J. T., & Rahman, Q. (2005). A reanalysis of five studies on sexual orientation and the relative length of the 2nd and 4th fingers (the 2D:4D ratio). *Archives of Sexual Behavior*, *34*(3), 341–356. https://doi.org/10.1007/s10508-005-3123-9

Milani, S., Zhang, J. Y., Zdaniuk, B., Bogaert, A., Rieger, G., & Brotto, L. A. (2023). Examining visual attention patterns among asexual and heterosexual individuals. *The Journal of Sex Research*, *60*(2), 271–281. https://doi.org/10.1080/00224499.2022.2078768

Miller, S. S., Hoffmann, H. L., & Mustanski, B. S. (2008). Fluctuating asymmetry and sexual orientation in men and women. *Archives of Sexual Behavior*, *37*(1), 150–157. https://doi.org/10.1007/s10508-007-9256-2

Miller, T. (2012). *Analysis of the 2011 Asexual Awareness Week Community Census*. https://acecommunitysurvey.org/wp-content/uploads/2017/04/aaw-2011-survey-results.pdf

Nicholls, M. E. R., Orr, C. A., Yates, M. J., & Loftus, A. M. (2008). A new means of measuring index/ring finger (2D:4D) ratio and its association with gender and hand preference. *Laterality (Hove)*, *13*(1), 71–91. https://doi.org/10.1080/13576500701751287

Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh Inventory. *Neuropsychologia*, *9*(1), 97–113. https://doi.org/10.1016/0028-3932(71)90067-4

© Sex Information and Education Council of Canada, 2025

Pagán Westfall, S. (2004). Glad to be A. *New Scientist*, *184*, 40–43.

Rahman, Q., Clarke, K., & Morera, T. (2009). Hair whorl direction and sexual orientation in human males. *Behavioral Neuroscience*, *123*(2), 252–256. https://doi.org/10.1037/a0014816

Ransil, B. J., & Schachter, S. C. (1994). Test-retest reliability of the Edinburgh handedness inventory and global handedness preference measurements, and their correlation. *Perceptual and Motor Skills*, *79*(3), 1355–1372. https://doi.org/10.2466/pms.1994.79.3.1355

Richards, G., Browne, W. V., Aydin, E., Constantinescu, M., Nave, G., Kim, M. S., & Watson, S. J. (2020). Digit ratio (2D:4D) and congenital adrenal hyperplasia (CAH): Systematic literature review and meta-analysis. *Hormones and Behavior*, *126*, 104867–104867. https://doi.org/10.1016/j.yhbeh.2020.104867

Richards, G., Medland, S. E., & Beaton, A. A. (2021). Digit ratio (2D:4D) and handedness: A meta-analysis of the available literature. *Laterality*, *26*(4), 421–484. https://doi.org/10.1080/1357650X.2020.1862141

Rieger G., Linsenmeier J. A., Gygax L., & Bailey J. M. (2008). Sexual orientation and childhood gender nonconformity: Evidence from home videos. *Developmental Psychology*, *44*, 46–58. https://doi.org/10.1037/0012-1649.44.1.46

Rieger, G., & Savin-Williams, R. C. (2012). Gender nonconformity, sexual orientation, and psychological well-being. *Archives of Sexual Behavior*, *41*(3), 611–621. https://doi.org/10.1007/s10508-011-9738-0

Rife, D. (1940). Handedness, with special reference to twins. *Genetics*, *25*(2), 0178–0186. https://doi.org/10.1093/genetics/25.2.178

Schwartz, G., Kim, R. M., Kolundzija, A. B., Rieger, G., & Sanders, A. R. (2010). Biodemographic and physical correlates of sexual orientation in men. *Archives of Sexual Behavior*, *39*(1), 93–109. https://doi.org/10.1007/s10508-009-9499-1

Seddon, B. M., & McManus, I. C. (1993). *The inheritance of left-handedness: A meta-analysis*. Unpublished manuscript.

Skorska, M. N., & Bogaert, A. F. (2017). Pubertal stress and nutrition and their association with sexual orientation and height in the add health data. *Archives of Sexual Behavior* *46*(1), 217–236. https://doi.org/10.1007/s10508-016-0800-9

Storms, M. D. (1980). Theories of sexual orientation. *Journal of Personality and Social Psychology*, *38*(5), 783–792. https://doi.org/10.1037/0022-3514.38.5.783

Swift-Gallant, A., Coome, L. A., Monks, D. A., & VanderLaan, D. P. (2017). Handedness is a biomarker of variation in anal sex role behaviour and recalled childhood gender nonconformity among gay men. *PLoS ONE*, *12*(2), e0170241. https://doi.org/10.1371/journal.pone.0170241

Swift-Gallant, A., Di Rita, V., Major, C. A., Breedlove, C. J., Jordan, C. L., & Breedlove, S. M. (2021). Differences in digit ratios between gay men who prefer receptive versus insertive sex roles indicate a role for prenatal androgen. *Scientific Reports*, *11*(1), 8102–8102. https://doi.org/10.1038/s41598-021-87338-0

Swift-Gallant, A., Shirazi, T., Puts, D. A., & Breedlove, S. M. (2022). Evidence for perinatal steroid influence on human sexual orientation and gendered behaviour. *Cold Spring Harbor Perspectives in Biology*, *14*(8), a039123. https://doi.org/10.1101/cshperspect.a039123

Watts, T. M., Holmes, L., Raines, J., Orbell, S., & Rieger, G. (2018). Finger length ratios of identical twins with discordant sexual orientations. *Archives of Sexual Behavior*, *47*, 2435–2444. https://doi.org/10.1007/s10508-018-1262-z

Williams, T. J., Pepitone, M. E., Christensen, S. E., Cooke, B. M., Huberman, A. D., Breedlove, N. J., Breedlove, T. J., Jordan, C. L., & Breedlove, S. M. (2000). Finger-length ratios and sexual orientation. *Nature*, *404*(6777), 455–456. https://doi.org/10.1038/35006555

Yule, M. A., Brotto, L. A., & Gorzalka, B. B. (2013). Mental health and interpersonal functioning among asexual individuals. *Psychology & Sexuality*, *4*(2), 136–151. https://doi.org/10.1080/19419899.2013.774162

Yule, M. A., Brotto, L. A., & Gorzalka, B. B. (2014). Biological markers of asexuality: handedness, birth order, and finger length ratios in self-identified asexual men and women. *Archives of Sexual Behavior*, *43*(2), 299–310. https://doi.org/10.1007/s10508-013-0175-0

Yule, M. A., Brotto, L. A., & Gorzalka, B. B. (2015). A validated measure of no sexual attraction: The Asexuality Identification Scale. *Psychological Assessment*, *27*(1), 148–160. https://doi.org/10.1037/a0038196

Yule, M. A., Brotto, L. A., & Gorzalka, B. B. (2017). Sexual fantasy and masturbation among asexual individuals: An in-depth exploration. *Archives of Sexual Behavior*, *46*(1), 311–328. https://doi.org/10.1007/s10508-016-0870-8

Zdaniuk, B., Milani, S., Makarenko, B., Marriott, N., Bogaert, A. F., & Brotto, L. A. (2025). Asexuality: Its relationship to sibling sex composition and birth order. *Archives of Sexual Behavior*, *54*(1), 51–64. https://doi.org/10.1007/s10508-024-03043-9

Zheng, L., & Su, Y. (2018). Patterns of asexuality in China: Sexual activity, sexual and romantic attraction, and sexual desire. *Archives of Sexual Behavior*, *47*(4), 1265–1276. https://doi.org/10.1007/s10508-018-1158-y

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