THE 2D:4D PROJECT

USING 2D:4D RATIO TO DETERMINE WHETHER
SEXUAL & ROMANTIC ORIENTATION ARE INFLUENCED BY HORMONAL BALANCES

Abstract

Romantic and sexual orientation are considered key parts of one's identity. But are they so much a part of one's "identity" as part of one's hormonal make-up? By using a biological marker for testosterone and estrogen levels, the ratio of index finger (second digit) to ring finger (fourth digit) length (aka 2D:4D), it was investigated whether hormonal balances influence romantic and sexual preferences - similar to many studies before it (Manning and Robinson, 2000; Manning and Robinson, 2003; Manning, Churchill, and Peters, 2007) - but differing in the critical aspects of looking not only into sexual preference but *romantic* preference as well, and taking into account the transgender and transsexual populace. For centuries, there has been research into the causes of homosexuality. But it's been cisnormative, and didn't view romantic and sexual orientation as separate entities. The findings of this study show that in fact, hormonal balances have a significant influence on sexual orientation in birth-males regardless of race or ethnicity (the effects of which were insignificant). However, 2D:4D is only a significant indicator of romantic orientation for birth-males in the right hand. In birth-females, the direction of the correlations between 2D:4D ratio and romantic and sexual orientation supported the same conclusion (that hormonal balances play a role in orientation); however, unlike with males, they were insignificant.

A notable secondary finding was that a participant's sexual orientation significantly predicted romantic orientation regardless of birth sex. It was also found that there was a significant positive correlation between the degree of homosexuality or homoromanticness and one's tendency to be polyamorous. Finally, it was observed that out of all combinations of sexual and romantic orientation, bisexual biromantics were most likely to be attracted to non-binary individuals (whether transgender, transsexual, genderfluid, or intersex).

Video summary: https://youtu.be/MVGoJincQL4

Background

There have been two primary schools of thought in the psychological community on the origins of homosexuality. Some have long suspected that, although homosexuality can be encouraged by certain life experiences, these instances are only catalysts for revealing one's tendency, and that innately, we have a predisposition to a particular sexual orientation. This is dubbed the constitutional outlook (Stungo and Chester, 1946; Hadfield, 1958; Hutchinson, 1959). This study seeks to confirm or disprove this outlook using prior constitutional research in the realm of 2D:4D ratio.

The Constitutionalists

The Constitutional Theoreticians

There have been a few social scientists, most notably the homosexual gay rights activist Karl Heinrich Ulrichs, who defended their constitutional standpoint on reasoning or experience alone. In Ulrichs' time the word homosexual didn't exist, so he called what we would describe today as a male homosexual, an "urning," and somewhat politically-incorrectly to today's standards, a "third sex." This so-called third sex had the desires of a woman in the physical form of a man since birth. Ulrichs was a proud proponent of the modern constitutional concept that you are born as you are born. Being a homosexual himself, and never observing any external cause for his orientation, was his defense (Levay, 1996). The heterosexual observer Aaron J. Rosanoff, a Russian-American psychiatrist who specialized in psychopathology and served as California State's Commissioner of Lunacy, wrote in the Seventh Edition of the Manual of Psychiatry in 1938 (it was originally translated from the French *Manuel de Psychiatrie* by Joseph Rogues de Fursac in 1905, but edited until it was unrecognizable), "It seems as difficult to turn a heterosexual boy homosexual as to accomplish the opposite feat..." (Fursac, 1938) Dr. Ellis Stungo, and the author of the popular English marriage guidebook, "Love Without Fear," Dr. Eustace Chester, professed in 1946 the similar psychological trend they observed, writing in The British Medical Journal, "The constitutional homosexual is incurable, and therapy is a complete waste of time in so far as it may remove or relieve concomitant neurotic features. In other words, treatment may convert an unhappy homosexual into a happy or less unhappy one, but will not affect the homosexual constitution of the patient." (Stungo and Chester, 1946) Magnus Hirschfeld, who we previously discussed as a physician with potentially abrasive assertions, also dabbled in psychology and gave the following eloquent speech, originally in German, about the nearly-unsuppressable nature of homosexuality:

> That the homosexual urge is not acquired but inborn is apparent from the phenomenon of its tenacity. Were it caused by external influences, it would be necessary to assume that it would yield to extraneous influences. In such a case, it would be possible not only for the heterosexual individual to become homosexual, but also, for a homosexual to become heterosexual. Both assumptions are at variance with the results of abundant experience. It is certain, on the other hand, that men and women of extroardinarily strong character and will-power were unable to change the direction of their sex-urge in spite of great effort. (Hirschfeld, 1936; Ellis, 1963)

The Constitutional "Hard" Scientists

Apart from the philosophical aspect, constitutionalists have also long drawn evidence for this notion from the realm of the medical sphere. (Krafft-Ebing, 1886; Weil, 1924; Hirschfeld, 1936; Neustadt and Myserson, 1940) Richard von Krafft-Ebing was the author of the revolutionary work Psychopathia Sexualis, published in 1886, in which he collected all published cases of homosexuality dating back to 1877. Referring to homosexual attraction, he stated, "I have designated this particular feeling as a functional sign of degeneration, and as a partial manifestation of a neuropathic state, in most cases hereditary." (Krafft-Ebing, 1886) The key word here is "hereditary." While he does believe that this hereditary characteristic is a scourge, it is inborn nonetheless. A. Weil, a German researcher, analyzed the measurements of 380 homosexuals and 1000 heterosexuals in 1924, and deduced that, "More than one-half to two-thirds of all homosexuals show deviation from the 'norm'; more specifically, the deviation here referred was anatomical deviation, which means there is a different physical build and constitution than in heterosexual men." (Weil, 1924; Ellis, 1963) The translation from the original German comes from Albert Ellis' culmination of pro and anti-constitutional studies, "Constitutional Factors in Homosexuality: A Re-Examination of the Evidence." Magnus Hirschfeld was another German physician who concurred with Weil that male homosexuals have more feminine body types and added that female homosexuals were also predisposed to have opposite-sex characteristics with respect to physicality. Another corroborator was Dr. Coppen at the Institute of London, who measured biacromial (shoulder) width, and bi-iliac (hip) width to give three groups of men (a control, a group of homosexuals, and a group of neurotic patients) androgyny scores based off these features but also qualitative things like gait. (Coppen, 1959) How much of these results comes from a place of prejudice is indeterminate. But, like with Krafft-Ebing, it is essential to overlook the negative connotations of their observations and appreciate it for laying the groundwork for later constitutionalists.

Anthony Bogaert, along with Ray Blanchard, additionally discovered in 1996 that men with higher fraternal birth orders, that is, more older brothers, were more likely to be homosexual. (Blanchard and Bogaert, 1996) Blanchard theorizes this is due to the fact that mothers with each succeeding son produce more H-Y antibodies, becoming immunized to male antigens. (Blanchard, 2001) Some theorize this is a survival adaptation, the purpose of which is to create a secondary provider within the family, due to the fact that homosexuals are incapable of naturally producing their own biological children, and thus will be capable of investing more in the wellbeing of their parents and cousins. (Wilson, 1975) Despite these convincing theories, there has been great inconsistency in the results of studies involving the effect of birth order on homosexuality. (Blanchard, 1997; Blanchard, 2001) One potential error is not inquiring into the number of brothers and sisters an individual has separately, as sisters for men have no impact on

their likelihood of homosexuality. Because women do not build immunity to female antigens with each successive daughter, any correlation with birth order to homosexuality in theory should be due to differing family structure. (Francis, 2008) For instance, some studies have found that female only-children are more likely to homosexual. (Hogan, Kirchner, Hogan, and Fox, 1980) Smaller families are inherently different relationally than larger ones. This is why to know if there is an effect of birth order for both female and male sexual or romantic orientation would be valuable in determining if it is inborn, environmental, or a combination of both.

On a hormonal front, Abraham Myerson and Rudolph Neustad, two endocrinologists, compared the urine of homosexual to heterosexual inmates and found consistent differences in the hormone balances of the groups. (Myerson and Neustad, 1940) Unfortunately, the small sample size of the study hardly makes it a reliable source. The more recent investigation into whether there are audible differences in the voices of male homo- and heterosexuals (Smyth, Jacobs, and Rogers, 2003) has a similar lack of certainty, as it's unknown whether the cause in vocal differences is hormonal or environmental. Franz J. Kallman used the unique situation of twins to attempt to associate genetics with sexual orientation, finding a strong correlation between the sexual orientations of twin pairs. (Kallman, 1952) However, this is by no means an open-and-shut case, because the fact that these twins had similar upbringings could not be controlled for, and the reason for this association could be just as easily attributed to their environments.

On a cerebral level, the neuroscientist Simon LeVay has uncovered that the anterior hypothalamus of the brain of male homosexuals is more similar to that of female heterosexuals than male heterosexuals. (LeVay, 1991) LeVay believes this implicates that sexual orientation is a "biological substrate," (LeVay, 1999) a characteristic that's the result of what's naturally there. These results have encouraged the investigation into whether brain lateralization is influenced by sexual and romantic orientation. It is widely known that the dominance of one hand of the other is influenced by the dominance of one side of the brain. Those who are more left-brained are more likely to be right-handed, and vice versa. (Parson, 1924; Francks et al., 2007) Since brain function is influenced by sexual orientation, and handedness is influenced by brain function, studies implicating the two have been conducted, but not enough for a conclusive agreement in the field. (Lindesay, 1987; McCormick, Witelson, and Kingstone, 1990) This leaves the topic of handedness in relation to orientation open to further research.

There have also been several studies that correlate pheromone preferences to sexual orientation (Martins et al., 2005; Savic, Berglund, and Lindström, 2005), but this is not a stable basis for proving

orientation is constitutional, because a person could develop pheromone preferences as a result of their proclivities.

Finally, most pertinent to this study is the relatively new development of constitutional research into the correlation of second digit to fourth digit (2D:4D) ratio to sexual orientation. In the Oxford journal *Human Reproduction* in 1998, John T. Manning and his colleagues established the basis for all following 2D:4D ratio investigations. In the study, Manning found that 2D:4D is negatively correlated to testosterone concentrations, and 2D:4D is positively correlated to oestrogen and prolactin - feminine hormone - concentrations, after controlling for sex, age, height, and weight (Manning, Scutt, Wilson, and Lewis-Jones, 1998). Essentially, this means that people with higher testosterone concentrations have a shorter index finger in relation to their ring finger than their counterparts with higher oestrogen and prolactin concentrations, and lower testosterone concentrations, in their blood circulation. This explains why 2D:4D is a sexually dimorphic trait. Testosterone concentrations are higher in males, and estrogen concentrations are higher in females, and these concentrations directly affect the growth of the second and fourth digits.

Investigating one step further, in 2002 a team led by Svetlana Lutchmaya, the author of "Prenatal Testosterone in Mind: Amniotic Fluid Studies," with Manning on the board, measured the levels of fetal testosterone and fetal estriodol in amniotic fluid of a sample of 33 unborn children. This was a longitudinal study, as the 2D:4D ratio of the developed child was measured at 2 years old, along with the hormonal measurements throughout the gestation process. Within each sex group, higher levels of prenatal testosterone negatively correlated with 2D:4D ratio, and higher levels of prenatal estriodol positively correlated with 2D:4D ratio (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, and Manning, 2004). This demonstrates that the 2D:4D ratio in postnatal individuals is a reliable indicator of prenatal hormone proportions, and not just a trait that coincidentally coincides with hormonal balances of the two sexes. What is notable here is that this shows that a deviation from the typical levels of prenatal testosterone or estriodol could have a permanent impact on the hormonal make-up of an individual.

Following that breakthrough, three years later, in 2007, Manning led his own collaboration with Andrew Churchill and Michael Peters, further connecting 2D:4D ratio to sexual orientation, and consequently sexual orientation to prenatal hormonal balances. In 2002, before it was proven that prenatal hormones have a permanent effect on hormonal balances, he had also done a smaller scale survey, with the results indicating that non-exclusive homosexuals (meaning they had sexual attraction to both men and women) on average had hypermasculinized (lower 2D:4D) ratios. But while this was true for evenly bisexual men, the mean 2D:4D ratio actually increased for each degree the homosexual preference became greater, meaning the more, or completely, exclusively homosexual men had hypomasculinized

(higher 2D:4D) ratios. (Manning and Robinson, 2000) The new survey, titled Sex I.D., was held on the BBC Science and Nature Website and was taken by 255,116 participants (Manning, Churchill, and Peters, 2007). The trio hypothesized that 2D:4D ratio in heterosexual men would vary from place to place, but that in every particular location, the 2D:4D ratio of homosexual men will be higher relative to the native population (Manning and Robinson, 2003). The participants were given instructions on how to measure their 2D:4D ratio. All data was self-reported. The results confirmed that 2D:4D ratio is a sexually-dimorphic trait, and revealed that different racial groups have different strengths of the sexual dimorphism.

Most pertinently for our purposes, it was also unveiled that in white men, there was lower 2D:4D in heterosexuals compared to homosexuals or bisexuals. This, potentially, is the biological evidence constitutionalists need to prove that sexual orientation is inherent. However, men of other races did not have a significant difference in 2D:4D depending on sexual orientation. Neither did women of any race. There *was* an effect both for women and men of different races that complied with the trend, but not one that was large enough to be considered significant. The results for white women in this study are inconsistent with several other studies (e.g. Williams et al., 2000) and "leaves the field in disarray," (Manning et al., 2007) which is a gap that must be addressed by another comprehensive study. In fact in a study the year prior, the exact reverse was found, and the insignificance was among men but not women. (Kraemer et al., 2006) Additionally it was discovered that mean 2D:4D in the left hand is slightly lower than in the right, so the hand selected for all future testing must be controlled.

It is also important to note that in the discussion, Manning claimed the study supports that 2D:4D measured from photocopiers has a lower mean 2D:4D than that measured directly from the fingers by trained observers (Manning et al., 2005). Samples from the UK and US measured from photocopies had higher mean 2D:4D than those in this study, which were self-reported. Their conclusion was that direct measurement is more likely to give more realistic mean 2D:4D. Photocopiers can have a distortional effect on the fingers because of the pressure required for the placement of the hand on the flatbed scanner. In a correspondence with Dr. Manning that I had in 2017, where he reviewed my methodological plan, he advised me as to the critical importance of this "measurement artefact," elucidating that, "in comparison to directly measured 2D:4D's [sic], the 2D:4D ratios calculated from photocopies or scans (indirect 2D:4D) are lower and show greater sex differences. This means that relative finger lengths are influenced by the indirect methodology such that 4D appears longer than 2D and the effect is greatest in males…" This has led me to decide on collecting data using solely direct finger measurement, in order to avoid the "downward pressure of the hand [which] may distort the fleshy fingers" (Ribiero, Neave, Morais, and Manning, 2016) that comes hand-in-hand with photocopying, and to also use self-reported measurement,

in order to confirm or refute that there are more "extreme values" from subjects who incorrectly follow the measurement procedure using this method, (Caswell and Manning, 2007) and provide future reference about the general skew of self-reported measurements in comparison to surveyor-collected measurements.

The Challenges

Aside from the purported issues of self-reported measurement, I have amassed a compilation of other complications that have been overlooked in investigating 2D:4D's relationship to sexual preference. Firstly, many 2D:4D studies ask for nationality of their subject, but they do not ask for the genetic composition of their subject, as in their parents' origins and complete racial profile. This is critical to accurate results because it has been found that 2D:4D does not vary simply by broader race, but by specific countries, (Manning, Fink, and Trivers, 2014) which have unique gene pools. Secondly, surveys currently include transexuals and transgenders without knowing it, because they do not inquire into the distinction between the current sex and the original sex of a person. Here's an example of how this could skew results: Say we have a person who is born male. This person has a slightly feminine 2D:4D ratio for a boy, but for a girl it would be slightly masculine. Now when this person's older, they physically transition to a female. Their 2D:4D ratio is slightly masculine for their physical sex now, because finger ratio does not change even when you go through estrogen treatment, as "there is some degree of feminization that has taken place that cannot be reversed with exogenous testosterone." (Unger, 2016) 2D:4D ratio is one of those types of feminization. When they were born they had a slightly feminine ratio for their assigned sex (male). So, this physically transitioned person, after a combination of surgical and hormonal treatments, such as vaginoplasty (Horbach et al., 2015), breast augmentation (Weigert, Frison, Sessiecq, Al Mutairi, and Casoli, 2013), and estrogen supplementation (Unger, 2016), is straight (as a biological gender-affirmed female) but based off of what their birth sex was, their 2D:4D ratio did have the expected effect on sexual preference. If we didn't know this person had transitioned, because it would not even be apparent face to face, we would conclude that there was an unexpected effect on sexual orientation, because a woman with a slightly masculine ratio is less likely to be straight. With about thirty-nine out of every ten thousand people (Meerwijk and Sevelius, 2017) there has likely been an issue of this sort, where a person's current gender or sex in contrast to their birth could affect statistical significance of the correlation between 2D:4D and sexual orientation in past studies. That would be roughly 918 people in the BBC study - had it been accounted for. Thirdly, the asexual romantic, the person who desires a romantic relationship without a sexual aspect, has never been taken into consideration. Finally, information on whether a person was born intersex or is currently intersex has not been collected in prior studies, which is essential to determining if 2D:4D is an accurate indicator of sexual and romantic orientation based off of birth sex. It has been theorized that "the frequency of

deviation from the ideal male or female... may be as high as 2% of live births." (Blackless et al., 2000) This portion of the population may have previously been a significant source of error.

The Acquirists

The Acquirist Viewpoint

The other viewpoint is the "acquired" (Freud, 1920) stance, where homosexuality is the result of a perverse upbringing (Bender and Paster, 1941), sexual abuse (Satinover, 1999; Tomeo, Templer, Anderson, and Kotler, 2001), a particular scarring experience (Hadfield, 1966; Gundlach, 1977), gender-confusion (Whitam, 1977; Koenig, 1979), or an inflated ego (Milton and MacDonald, 1984). Boiled down, the cause is environmental. This often leads to attempts to solve the "pathological" (Bieber, 1976) imbalance with psychotherapy. (Laycock, 1950; Brandon, 1975) In homosexual-treatment centers, electro-convulsive therapy has been another common practice. (Smith, Bartlett, and King, 2004; King, Smith, and Bartlett, 2004) Psychoanalysis, rather than medical study or philosophical theory, has been used to support the acquired position (Jonas, 1944; Bieber et al., 1962). In the same journal that Chester and Stungo presented their case for constitutionality, Clifford Allen, who wrote the psychology primer "Modern Discoveries in Medical Psychology," attributed homosexual orientation to bonding with the parent of the opposite sex. In the journal he writes,

> The true factor, as your correspondent Dr. Gilsenan points out, is in the home circumstances. The parent of the same sex is antipathetic to him. This is my most invariable finding. This leads to the patient failing to mould himself upon this parent, and instead he unconsciously moulds his mind on (in psychological terminology, 'introjects' or 'identifies' himself with) the parent of the opposite sex. This occurs from the earliest childhood, and hence the idea of being 'born homosexual' which many patients elaborate. The result is that the man acquires feminine traits and is capable of loving only those of the same sex. (Allen, 1946)

Fredrick Koenig concurred with Allen's perspective. In a compelling study consisting of 23 male homosexuals and 23 male heterosexuals, when asked to illustrate an ideal family, homosexuals tended to draw the mother larger than their heterosexual counterparts. Koenig interpreted this as evidence that "socialization that is predominantly maternal" leads to "cross-sex identification" and thus homosexuality. (Koenig, 1979)

The Constitutional Rebuttal

On the other hand, there a several ways that a constitutionalist may justify this outcome, for example: 1) The subjects only identified with the opposite sex due to their initial preference. 2) There is no connection between intersexuality and homosexuality, as "gender identity is a separate phenomenon, separate from homosexuality" (Braverman, 1973) therefore homosexuals merely imprint on heterosexual women more than heterosexual men because they identify with a fellow minority (Meyer, 2003) that faces similar wage and employment discrimination (Byrne, 1993; Kennelly, 2006; Thornton, 2010; Sabia, 2014), has a common sexual preference, similar occupation (Ellis, 1915; Baumle, Compton, and Poston,

2009), and personality type (Berenbaum and Hines, 1995; Berenbaum and Snyder, 1995; McLelland, 1999; Hampson, Ellis, and Tenk, 2007). Or, 3) women tend to be more nurturing (Jackson, 1989) and are therefore more accepting of something that society sees as a "flaw" in their child. Please note that the previous theories do not all necessarily reflect my opinions, and are mainly to demonstrate the difference in reasoning between constitutionalists and "acquirists." Constitutionalists may also argue that Allen and Koenig's reasoning is flawed because the same-sex parent is virulent to the child as a *consequence* of their demeanor. And many may say that Dr. Allen's "invariable" observation is in truth, unreliable, as other acquirists have used their observance of the exact opposite to prove their stance. Lesbians are thought to reject men as a result of early sexual abuse from a male figure. In a report of 115 cases of rape or attempted rape by the psychologist Ralph Gundlach, he ascertained that "lesbians tended to reject all men as sexual partners or companions" (Gundlach, 1977) as an outcome. So, it is evident that acquirists tend to pin the blame for homosexuality on the father, regardless of the gender of the homosexual; this of course is yet another misconception, because lesbians are more frequently targeted for abuse as a result of their orientation. (Black et al., 2011) Returning to the original point, this disunity in the acquirist community substantiates that introjection is a misconception. Fathers are typically the physically and/or sexually abusive member of a household, (Williams, 1981; Davis, 1987) so acquirists come to the unreasonable verdict that fathers are the root of the paraphilia both for female and male homosexuals. Another way to put this is that both antipathy from the same-sex parent (resulting in introjection on the opposite sex) and antipathy from the opposite-sex parent (resulting in repulsion to the opposite sex) are potential causes of homosexuality within the acquirist community, demonstrating there is no concrete explanation.

The In-Betweeners

Some do not fit the label of "acquirist" or "constitutionalist" and even entertain the meshing of the two, the biological component causing emotional instabilities that lead to homosexuality. (Kallman, 1952; Hutchinson, 1959) The psychiatrist Franz Josef Kallman stated that genetics may have an effect "on the rates of development of neuro-psychological mechanisms involved in identification processes and other aspects of object relationships in infancy." (Kallman, 1952) Put into layman's terms, Kallman was saying that the genes of homosexuals give them a tendency to develop warped psyches. Following Kallman, after a review of the literature in the field of homosexual study, the British ecologist George Evelyn Hutchinson came to a parallel conclusion, publishing his assertion that "psychoanalytic theory suggests that the most probable mode of operation of the genetic determinants is on the rates of the development of neuro-psychological mechanisms involved in identification processes and other aspects of object relationship in infancy." (Hutchinson, 1959)

The Call to Action

This division within the psychological community as to whether orientation is acquired or inherent, and the outdatedness, bias, discordance, and general unreliability in much of the constitutional research that exists, is why it is our responsibility to utilize the large LGBT community and ethnic diversity within New York City to gain indisputable insight into this topic. This survey will encompass groups that hadn't been accounted for in the past, such as transexuals, transgenders, intersexuals, and those with differing romantic preferences to their sexual preferences, as well as take into consideration each participant's detailed ethnic origin rather than simply their nationality.

This study intends to answer the question: do prenatal hormone proportions (displayed through 2D:4D ratio) affect sexual and romantic orientation? The deeper question answered by the outcome of that question is: is sexual and romantic orientation inborn or acquired?

Anticipated Results

I hypothesize that for birth-males a preference for men, whether sexual or romantic, will positively correlate with 2D:4D ratio, whether for the left or right hand. For birth-females, a preference for women, whether sexual or romantic, will negatively correlate with 2D:4D ratio, whether for the left or right hand. I also hypothesize that non-binary and non-heterosexual individuals will be more likely to be attracted to non-binary individuals, and predict that non-heterosexuals will be more likely to be polyamorous. I theorize that homosexual males are more likely to have a greater fraternal birth order, and that female orientation will not be affected by birth order at all. In general, I believe that the results will suggest that sexual and romantic preference is to a great extent biological.

Methods

Participants were surveyed on the street and randomly selected without consideration to sex, age, gender, or race. Locations of surveying were also randomized by using an online random neighborhood generator. The surveyor entreated people to take the survey by saying the following:
"Excuse me, could you please take a survey for my research project?" The survey begins with a question on hand-related injuries, so that those who have had their 2D:4D ratio altered in both hands may be excused from proceeding, and those with only one hand with prior injury have that hand excluded from the study. The rest of the survey covers the participant's height, weight, birth order, age of mother at birth, birth date, birth sex, current gender (or lack thereof), and current sex, as well as their birth parents' race, country of origin, and ethnicity. The number of male and female pregnancies the mother had preceding them is also asked. Sexual and romantic orientation are reported on a scale of 0 to 7, 0 being exclusively heterosexual/romantic, 6 being exclusively homosexual/romantic, and 7 being asexual/aromantic. This is

an adaptation of the Kinsey Scale. (Kinsey et al., 1948, 1953) Definitions of sexual and romantic orientation, and the distinction between the two, are included. There are two rows so that each may be reported separately. Finally, the survey concludes with a question on whether the participant is attracted to nonbinary individuals who match in gender with their sexual or romantic preference, and another on whether they are monogamous, occasionally polyamorous, or exclusively polyamorous. A Neiko 01409A Electronic Digital Caliper with Extra Large LCD Screen is used for measurement of the participant's second and fourth digits, from the middle of the participant's bottom crease of the finger to the very tip of the skin (not the nail). It has an accuracy of .02 millimeters. The caliper can be found at this link: https://www.amazon.com/gp/product/B000EJUBBU/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&psc=1. 2D:4D ratio was calculated by dividing the second digit length measurement by the fourth digit length measurement on each hand.

After data collection, bivariate correlations were used to relate left and right hand 2D:4D ratios, separately, to sexual and romantic orientation; relate sexual and romantic orientation to degree of polyamory; relate age of mother at birth to sexual and romantic orientation; relate number of mother's preceding children to sexual and romantic orientation; relate number of mother's preceding female children to sexual and romantic orientation; relate number of siblings to sexual and romantic orientation; and relate age to sexual and romantic orientation. Descriptive statistics were used to relate sexual and romantic orientation to attraction to any non-binary group (transexuals, transgenders, genderfluids, and those who are intersex).

Results

For the results about the validity of 2D:4D ratio as an indicator of sexual and romantic orientation, sexually transitioned and transitioning individuals were excluded in the analysis, due to evidence that hormone injections have an effect on 2D:4D in mature adults (Li, et al., 2017). Genderfluid participants and transgender participants who had never begun the process of transitioning were also excluded because their gender identities (or lack thereof for genderfluids) didn't correspond with their physical sex which strongly influences 2D:4D ratio (Manning, Scutt, Wilson, and Lewis-Jones, 1998). Hands with injuries (past or present) that would affect 2D:4D ratio were also excluded in those relevant sections.

Sexual Orientation Predictor:

A model consisting of birth female right hand 2D:4D ratios did not significantly predict sexual orientation. $F(145, 327) = -0.088$, $p > .05$. A model consisting of birth female left hand 2D:4D ratios did

not significantly predict sexual orientation. F (148, 327) = -0.046, p > .05. In the following analyses, the asexual participant was excluded, due to the small sample size of asexuals (only one participant), and due to the rating of 7 being arbitrary and not related to degree of homosexuality. A model consisting of birth male right hand 2D:4D ratios significantly predicted sexual orientation. F (131, 327) = 0.05, p = .003, p < .05. A model consisting of birth male left hand 2D:4D ratios significantly predicted sexual orientation. F (135, 327) = 0.179, p = .038, p < .05.

Romantic Orientation Predictor:

A model consisting of birth female right hand 2D:4D ratios did not significantly predict romantic orientation. F (143, 327) = -0.100, p > .05. A model consisting of birth female left hand 2D:4D ratios did not significantly predict romantic orientation. F (147, 327) = -0.070, p > .05. A model consisting of birth male right hand 2D:4D ratios significantly predicted romantic orientation. F (131, 327) = .285, p < .001. A model consisting of birth male left hand 2D:4D ratios did not significantly predict romantic orientation. F (135, 327) = 0.160, p = .063, p > .05.

Key for Column Titles: Kinsey Scale Rating (0 - 7), Sexual or Romantic Orientation (S / R), Birth Sex / Current Sex / Gender of Participant: Male or Female (M / F), Hand: Right or Left (R / L)
All values are for 2D:4D ratio.

	0SMR	**0SML**	**1SMR**	**1SML**	**2SMR**	**2SML**	**3SMR**	**3SML**
Number	80	85	6	5	8	8	8	8
Mean	0.964	0.969	0.984	1.017	0.963	0.991	0.960	0.977
Stdev.	0.036	0.042	0.041	0.030	0.026	0.035	0.029	0.027
Min.	0.874	0.870	0.934	0.983	0.907	0.948	0.924	0.934
25th %ile	0.939	0.939	0.961	1.002	0.956	0.961	0.938	0.957
50th %ile	0.963	0.962	0.976	1.009	0.970	0.989	0.962	0.976
75th %ile	0.992	0.992	1.007	1.030	0.973	1.007	0.977	1.001
Max.	1.078	1.061	1.046	1.062	0.996	1.052	1.000	1.010

	4SMR	4SML	5SMR	5SML	6SMR	6SML	7SMR	7SML
Number	3	4	4	4	22	21	1	1
Mean	0.971	0.994	0.978	0.969	0.993	0.991	1.003	0.963
Stdev.	0.033	0.014	0.024	0.045	0.033	0.042	N/A	N/A
Min.	0.937	0.974	0.953	0.907	0.940	0.873	1.003	0.963
25th %ile	0.955	0.989	0.962	0.956	0.972	0.970	1.003	0.963
50th %ile	0.973	0.999	0.977	0.977	0.990	1.001	1.003	0.963
75th %ile	0.989	1.003	0.994	0.990	1.013	1.007	1.003	0.963
Max.	1.004	1.005	1.005	1.014	1.072	1.085	1.003	0.963

	0RMR	0RML	1RMR	1RML	2RMR	2RML	3RMR	3RML
Number	85	90	10	10	4	3	4	4
Mean	0.965	0.971	0.964	0.990	0.970	0.963	0.975	0.987
Stdev.	0.035	0.042	0.046	0.045	0.019	0.018	0.044	0.022
Min.	0.874	0.870	0.896	0.927	0.951	0.948	0.924	0.956
25th %ile	0.942	0.946	0.929	0.956	0.956	0.953	0.960	0.981
50th %ile	0.964	0.963	0.963	0.997	0.968	0.958	0.972	0.995
75th %ile	0.991	0.999	0.994	1.022	0.982	0.971	0.987	1.001
Max.	1.078	1.061	1.046	1.062	0.992	0.984	1.032	1.001

	4RMR	4RML	5RMR	5RML	6RMR	6RML	7RMR	7RML
Number	3	4	4	4	22	21	N/A	N/A
Mean	0.971	0.994	0.978	0.969	0.993	0.991	N/A	N/A
Stdev.	0.033	0.014	0.024	0.045	0.033	0.042	N/A	N/A
Min.	0.937	0.974	0.953	0.907	0.940	0.873	N/A	N/A
25th %ile	0.955	0.989	0.962	0.956	0.972	0.970	N/A	N/A
50th %ile	0.973	0.999	0.977	0.977	0.990	1.001	N/A	N/A
75th %ile	0.989	1.003	0.994	0.990	1.013	1.007	N/A	N/A
Max.	1.004	1.005	1.005	1.014	1.072	1.085	N/A	N/A

	0SFR	0SFL	1SFR	1SFL	2SFR	2SFL	3SFR	3SFL
Number	83	85	15	16	10	9	18	19
Mean	0.985	0.992	0.996	1.000	0.992	1.004	0.984	0.987
Stdev.	0.037	0.062	0.033	0.036	0.034	0.052	0.026	0.030
Min.	0.891	0.912	0.944	0.920	0.947	0.940	0.948	0.936
25th %ile	0.960	0.966	0.979	0.982	0.962	0.973	0.962	0.964
50th %ile	0.981	0.992	0.994	1.002	0.991	1.007	0.979	0.988
75th %ile	1.005	1.009	1.015	1.023	1.017	1.018	1.007	0.999
Max.	1.086	1.458	1.050	1.062	1.053	1.116	1.035	1.054

	4SFR	4SFL	5SFR	5SFL	6SFR	6SFL	7SFR	7SFL
Number	4	4	8	9	5	5	N/A	N/A
Mean	0.970	1.001	0.987	0.987	0.956	0.973	N/A	N/A
Stdev.	0.016	0.062	0.043	0.035	0.026	0.033	N/A	N/A
Min.	0.948	0.936	0.927	0.926	0.934	0.928	N/A	N/A
25th %ile	0.965	0.958	0.949	0.987	0.936	0.955	N/A	N/A
50th %ile	0.973	0.996	0.996	0.990	0.952	0.978	N/A	N/A
75th %ile	0.979	1.038	1.014	1.007	0.959	0.993	N/A	N/A
Max.	0.987	1.074	1.049	1.030	1.000	1.012	N/A	N/A

	0RFR	0RFL	1RFR	1RFL	2RFR	2RFL	3RFR	3RFL
Number	95	97	11	11	6	6	14	15
Mean	0.986	0.993	0.991	0.996	1.000	1.017	0.984	0.981
Stdev.	0.036	0.060	0.036	0.030	0.033	0.058	0.022	0.020
Min.	0.891	0.912	0.944	0.953	0.947	0.940	0.952	0.952
25th %ile	0.961	0.967	0.958	0.976	0.989	0.993	0.970	0.964
50th %ile	0.985	0.994	0.989	0.998	0.999	1.018	0.979	0.987
75th %ile	1.008	1.011	1.016	1.019	1.027	1.022	1.006	0.995
Max.	1.086	1.458	1.050	1.045	1.035	1.116	1.019	1.018

	4RFR	4RFL	5RFR	5RFL	6RFR	6RFL	7RFR	7RFL
Number	7	7	2	2	8	8	N/A	N/A
Mean	0.957	0.979	1.003	0.975	0.975	0.986	N/A	N/A
Stdev.	0.021	0.055	0.064	0.055	0.034	0.033	N/A	N/A
Min.	0.927	0.926	0.958	0.936	0.934	0.928	N/A	N/A
25th %ile	0.945	0.934	0.981	0.955	0.948	0.972	N/A	N/A
50th %ile	0.952	0.966	1.003	0.975	0.974	0.990	N/A	N/A
75th %ile	0.973	1.008	1.026	0.994	1.001	1.008	N/A	N/A
Max.	0.987	1.074	1.049	1.014	1.025	1.030	N/A	N/A

Non-Binary Attraction Predictor:

Sexual Orientation Rating	Romantic Orientation Rating	% Attraction to Transsexual Individuals	% Attraction to Transgender Individuals	% Attraction to Genderfluid Individuals	% Attraction to Intersex Individuals
0 heterosexual	0 heteroromantic	2.273% (4/176)	1.136% (2/176)	1.136% (2/176)	0.568% (1/176)
0 heterosexual	1-5 biromantic	14.286% (1/7)	14.286% (1/7)	14.286% (1/7)	0% (0/7)
1-5 bisexual	0 heteroromantic	17.241% (5/29)	24.138% (7/29)	13.793% (4/29)	10.345% (3/29)
1-5 bisexual	1-5 biromantic	39.394% (26/66)	43.284% (29/67)	43.284% (29/67)	28.358% (19/67)
1-5 bisexual	6 homoromantic	33.333% (1/3)	33.333% (1/3)	33.333% (1/3)	33.333% (1/3)
6 homosexual	1-5 biromantic	N/A	N/A	N/A	N/A
6 homosexual	6 homoromantic	24.138% (7/29)	20.69% (6/29)	31.034% (9/29)	13.793% (4/29)

Relationship Between Romantic & Sexual Orientation:

A model consisting of participants with varying sexual orientations significantly predicted romantic orientation. $F(321, 327) = 0.926$, $p < .001$. This demonstrates that there's a strong relationship between sexual and romantic orientation but it's not one-to-one.

Polyamory Predictor:

A model consisting of participants of varying sexual orientation significantly predicted tendency of polyamory. $F(322, 327) = -0.215$, $p < .001$. A model consisting of participants of varying romantic orientation significantly predicted tendency of polyamory. $F(321, 327) = -0.177$, $p < .01$, $p = .002$. This indicates that the higher a person rates themself on the Kinsey Scale, whether it be for romantic or sexual orientation, the more likely they are to be polyamorous or occasionally polyamorous.

Mother's Age at Birth Predictor:

A model consisting of participants with varying age of mother at birth did not significantly predict sexual orientation. $F(261, 327) = 0.074$, $p > .05$. A model consisting of participants with varying age of mother at birth did not significantly predict romantic orientation. $F(7, 326) = 0.003$, $p > .05$. This implies that there aren't any significant differences between younger and older mothers' hormonal balances or parenting styles that significantly affect the sexual and romantic orientations of their children, and if there are, they cancel each other out.

Age of Participant Predictor:

A model consisting of participants of varying ages did not significantly predict sexual orientation. $F(314, 327) = 0.025$, $p > .05$. A model consisting of participants of varying ages did not significantly predict romantic orientation. $F(314, 327) = 0.045$, $p > .05$. This signals that if there are generational differences that affect orientation, in New York City at least, they aren't strong enough to be significant.

Birth Order Predictor:

A model consisting of birth female participants with varying birth order significantly predicted sexual orientation. $F(142, 327) = 0.183$, $p < .05$, $p = .031$. Isolating participants who were born female and were not transgender, genderfluid, or transexual, this trend also held. $F(140, 327) = 0.177$, $p < .05$, $p = .037$. This suggests that the higher the number sibling a female is, the more likely they are to be higher rated on the Kinsey Scale, at least in New York City currently. This contradicts several prior studies, which claimed that "females are invisible to the birth order phenomenon." (Blanchard, 2001) A model consisting of birth male participants with varying birth order did not significantly predict sexual orientation. $F(145, 327) = 0.055$, $p > .05$, $p = .515$. Isolating participants who were born male and were not transgender, genderfluid, or transexual, this remained consistent. $F(143, 327) = 0.058$, $p > .05$, $p = .489$. This doesn't directly contradict prior studies the way the last finding does because this is not a

correlation with the number of preceding male siblings, which are supposed to have the influence. (Blanchard, 1996) It does indicate however, that this influence, if there is any, is not strong enough to overpower the influence of confounding variables (e.g. preceding female siblings). A model consisting of participants (birth sex, gender, and current sex aside) with varying birth order did not significantly predict sexual orientation. $F(288, 327) = 0.112$, $p > .05$, $p = .058$.

Discussion

One can only surmise as to why sexual and romantic orientation was indicated by 2D:4D - and thus prenatal hormone balances - for birth-males and not for birth-females, but it may have to do with the lesser degree of stigma surrounding bisexuality for women in comparison to men, at least from the heterosexual male perspective. (Herek, 2002; Steffens & Wagner, 2003) It would make sense from a societal viewpoint that the acceptance of cisgender, heterosexual men of bisexual women would be more important to decreasing stigma than say the acceptance of cisgender, heterosexual women of bisexual women because 21st century society still experiences the remnants of the indisputable patriarchy of the distant past. (Ruggles, 2015) And this theory lines up with past studies of attitudes towards bisexuals. Regardless of whether female heterosexuals in the early 21st century had significantly lower approval ratings for bisexuals than homosexuals, heterosexual men had relatively even approval ratings for bisexuals and homosexuals, and higher approval ratings for females in comparison to their male bisexual or homosexual counterparts. (Herek, 2002)

As for why the relationship between sexual and romantic orientation isn't a direct correlation, that may be influenced by societal stigma against homosexuals as well. Settling down with someone of the same sex is less appealing when there's discrimination against homosexuals (Black et al., 2011) – and perhaps even more intensely, homoromantics. If you have a bisexual inclination, why not choose to have long-term, public relationships with people of the opposite sex, and mainly stick to more private, physical relationships with people of the same sex? This fear is likely why a far greater proportion of bisexuals in this study are heteroromantic (29.293%) rather than homoromantic (3.03%).

Finally, though not the main focus of the study, there were some intriguing relationships between sexual and romantic orientation and likelihood of attraction to non-binary individuals (transsexual, transgender, genderfluid, and intersex). Bisexual biromantics were most likely to be attracted to transsexual, transgender, and genderfluid individuals while bisexual homoromantics were most likely to be attracted to intersex individuals of all groups surveyed. (*Non-Binary Attraction Predictor*) Bisexual heteroromantics however, had even lower rates of attraction to non-binary individuals than homosexual homoromantics, who had lower rates of attraction to non-binary groups than bisexual biromantics and

homoromantics. This feeds into my prior theory on a factor in why sexual and romantic orientation isn't a direct correlation, which supports the idea that bisexual heteroromantics are more susceptible to societal judgment in general. This would explain why bisexual heteroromantics are less likely to admit or experience attraction to non-binary individuals, as non-binaries are another marginalized group like homosexuals.

There are two possibilities as to why a higher Kinsey Scale rating correlates with a greater degree of polyamory. The first is that those who are not exclusively heterosexual or heteroromantic have had to learn to be less sensitive to societal norms due to their orientation, so they're also more likely to adopt a less traditional relationship structure, as opposed to monogamy. The second is that they were initially less sensitive to societal norms, allowing them to act on their homosexual or homoromantic tendencies, meaning that this mindset translates over, allowing a higher percentage of individuals who are higher-rated on the Kinsey Scale (in comparison to lower-rated on the Kinsey Scale) to act on their polyamorous impulses.

In general the results of this study have one truth in common: that who we love is guided by society's expectations of us and what is considered "normal." The more aware we are that this forced normality is abnormal, the more freely the average person will be able to live.

A continually updated (aka "living") version of this paper is maintained at: http://bit.ly/2D4Dliving
If you view it, there may be new developments.

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