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The gay gene(s)? Rethinking the concept of sexual orientation in the context of science

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Abstract

I argue that scientists should adopt a sexual orientation view that includes 'internal' sexual orientation markers such as desire, fantasies, and attraction, plus self-identification, and that these two markers should line up. By 'internal' markers, I mean inner states or processes of the agent. This can be contrasted with 'external markers', by which I mean, behaviours of the agent. I begin by critically reviewing four genetic studies of sexual orientation that are representative of the literature. I look at how each of these studies deploy the concept of 'sexual orientation', and show a) that they are each using different notions, and b) that none of the notions are satisfactory. I argue that these accounts have a very limited amount of predictive and explanatory power. Following this, I outline what an account of sexual orientation that has more predictive and explanatory power might look like. I argue that this account will be one that includes internal markers and self-identification.

Keywords Sexual orientation · Sexuality · Genetics · Metaphysics · Concepts

Introduction

In 2013, Hamer, a well-known geneticist for his work on sexual orientation, claimed that '[…] genes are the single most important factor in determining a person's sexual orientation and outweigh all known shared environmental factors' (Hamer 2013). In this paper, I argue that we are far from being able to accept or reject a claim like this. An examination of past and current genetic studies of sexual orientation will reveal problematic metaphysical assumptions that need to be addressed before we are in a position to accept, or reject, a claim like the one put forth by Hamer.

I show that different scientists understand sexual orientation differently. Some understand sexual orientation through a mix of sexual orientation markers such as self-identification, attraction, fantasy, and sexual behaviour, while others understand

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sexual orientation through just one sexual orientation marker, such as sexual behaviour. This inconsistency means that scientists are measuring and talking about different kinds of things (concepts with different extensions) when talking about sexual orientation. If this is right, then a claim like Hamer's is problematic because, as will see by critically engaging with the genetics literature, we do not have the data nor the conceptual tools to assess a claim like this.

Our concept of sexual orientation will be more useful–be more predictive and have greater explanatory power–if we have a clear understanding of what determines its extension. In this paper, I argue that scientists should adopt a sexual orientation view that includes 'internal' sexual orientation markers such as desire, fantasies, and attraction[1] plus self-identification, and that these two markers should line up. By 'internal' markers, I mean inner states or processes of the agent. This can be contrasted with 'external markers', by which I mean, behaviours of the agent.

I begin by critically reviewing four genetic studies of sexual orientation that are representative of the literature (§2). I look at how each of these studies deploy the concept of 'sexual orientation', and show a) that they are each using different notions, and b) that none of the notions are satisfactory. I argue that these accounts have a very limited amount of predictive and explanatory power (§3, 4, and 5). Following this, I outline what an account of sexual orientation that has more predictive and explanatory power might look like (§6). I argue that this account will be one that includes internal markers such as desire, fantasies, and attraction plus self-identification.

Four sexual orientation views in the genetics literature

In this section, I work through four common ways of understanding sexual orientation in the genetics literature[2] and show that there is currently no agreed upon way to understand and classify sexual orientation. In §3, §4, and §5 I come back to a more detailed criticism of these studies. The point I want to start making here is that if different genetic studies employ different methods for classifying sexual orientation, then researchers will be in danger of talking past each other about their results. That is, they will be incapable of agreeing, or disagreeing, with each other.

A four-factor account (self-ID, attraction, fantasy, and behaviour)

Hamer et al.'s (1993) study is a good place to begin for two reasons: 1) this study has formed the foundation for subsequent work in this area, and 2) the kind of

[1] I am not committed to any one of these markers. Furthermore, these markers need not necessarily be 'sexual', they can also be romantic.

[2] I discuss the following four genetic studies of sexual orientation because these studies are illustrative of the problems that I've found in the literature.

classificatory mistakes that were made in this study were carried over to studies that tried to replicate the study as well as to other studies studying sexual orientation[3] Hamer et al. appealed to a variety of markers typically associated with sexual orientation. In their study,

> 'Sexual orientation was assessed by the Kinsey scales, which range from 0 for exclusive heterosexuality to 6 for exclusive homosexuality. Subjects rated themselves on four aspects of their sexuality: self-identification, attraction, fantasy, and behavior' (Hamer et al. 1993, 321).

Each of the four markers were 'added up' based on the evaluation of three characteristics: consistency, reliability, and stability. Very briefly, the first characteristic tested for consistency of answers across all four scales using a correlation coefficient that ranged from 0 (completely inconsistent) to 100 percent (completely consistent). They tested reliability by appealing to results from other studies which reported a strong correlation between penile responses (penile plethysmographs) and self-reported Kinsey scores (this allowed them to take self-report as a reliable report). Lastly, they tested stability by appealing to the Klein Grid and testing for each scale across different time periods. They found stability across different time periods in all scales but behaviour. In cases where behaviour was not 'stable' across different time periods, this was written off as 'sexual experimenting'. This allowed Hamer et al. to ascribe their study participants a discrete and dichotomous sexual orientation category: either homosexual or heterosexual,[4] independently of their sexual behaviour. This means that behaviour was only taken into account if it was stable and aligned with self-ID, attraction, and fantasy markers.

A three-factor account (self-ID, corroboration, and stereotypes)

Consider a second study, where sexual orientation was understood through a mix of three different markers: self-identification, corroboration from a secondary source and stereotypes. In 'Male Homosexuality: Absence of Linkage to Microsatellite Markers at Xq28', (1999), Rice et al. put an advert out in two gay news magazines, recruiting families that had at least two gay brothers. The individuals that responded to the advert 'volunteered information about the sexual orientation of individuals in their families, including siblings, parents, uncles, aunts, and first cousins, although all members of the extended family were not directly interviewed' (1999, 666). This was the first time they assessed sexual orientation. We can identify this first assessment as 'self-identification' in the case of the individuals that responded to the advert and 'other-identification' in the case of the relatives (since these relatives were ascribed a sexual orientation by the individuals who responded to the advert). Later, when it came time for the molecular analysis, they

[3] For examples, please see: (Bocklandt et al. 2006; Hu et al. 1995; Mustanski et al. 2005; Pattatucci et al. 1998).

[4] For more on this, please see chapter 3 of The Science of Desire (1994).

assessed sexual orientation for a second time. The participants who took part in the molecular analysis included the index subjects[5] and their gay brothers. According to Rice et al.:

> 'Sexual orientation was confirmed for all subjects[6] at the time of blood sampling by the direct questioning of a gay interviewer. The index subject read gay magazines and volunteered that he was gay, and this observation was corroborated by interviewing the gay brother' (Rice et al. 1999, 666).

Quite a few things require unpacking from this passage. First, it is important to highlight the appeal to gay magazines and self-identification as markers of the study participants' sexual orientation. Rice et al. inform us early on in their paper that the adverts for this study were published in two gay magazines, and this is made quite clear. However, this is not what is going on in this passage. Rice et al. seem to be appealing to the fact that the index subject read gay magazines and self-identified as gay men as sexual orientation markers. That is, this was taken as information that helped confirm the sexual orientation of the index subjects.

Furthermore, Rice et al. report that the index subject's sexual orientation was corroborated by interviewing the index subjects' gay brothers and, in a sense, the gay brothers seem to have also corroborated the information provided by the index subjects that they themselves are gay by taking part in the study. According to Rice et al. then, sexual orientation also has to do with how others, other than the person in question, understand their sexual orientation. That is, there seems to be something important about another person's assessment of one's own sexual orientation. It would have been interesting to see what Rice et al. would have done if the answers provided by the study participants didn't neatly line up. That is, if some of the brothers came back and said that their brother (an index subject) was not gay, but bisexual, for example, this would have been a good indicator of how much weight another person's assessment of one's own sexual orientation has over other sexual orientation markers used by Rice et al.

Next we have the gay interviewer whose job it was to confirm all of the participants' (index subjects' and their gay brothers') sexual orientation. It is not clear what questions were asked by the gay interviewer or why it was important or relevant that the interviewer was gay. It is not clear if the gay interviewer was supposed to help the participants feel more comfortable due to the nature of the study or if Rice et al. were assuming that gay people have some kind of "gaydar" ability which provides them special access to a person's sexual orientation. What is clear is that the gay interviewer was part of assessing the study participant's sexual orientation.

[5] Initially, 182 individuals responded to the advertisement for the study. The people who responded to these advertisements are the 'index subjects'. The other participants in the study, including the brothers that participated in the molecular analysis, were recruited through the index subjects.

[6] 'all subjects' here refers to all subjects who participated in the molecular analysis.

A two-factor account (self-ID and sexual feelings)

The third study, by Sanders et al. (2017)'[…] classified men as homosexual based on both their self-reported sexual identity and sexual feelings (Kinsey 5–6)' (Sanders et al. 2017, 3). According to Kinsey et al. (1949), a Kinsey 5 is someone who is 'predominantly homosexual, but incidentally heterosexual', while a Kinsey 6 describes someone that is 'exclusively homosexual'. Under this classificatory system, there is currently an open question about whether the 1–5 Kinsey categories should be classified as "bisexual" or whether we should only classify the Kinsey 3 as bisexual (1949, 656).

It is important to highlight two things in this study. The first is that Sanders et al. used two Kinsey scale markers: self-identification and sexual feelings. And the second is that the sexual orientation category used by Sanders et al. to define homosexuality was 'predominantly homosexual' (Kinsey 5–6), which is quite different to the original Kinsey classification system. According to Sanders et al., anyone who scored between a Kinsey 5–6 was classified as homosexual.

In an earlier study, Sanders et al. (2015) claim that sexual orientation tends to be bimodally distributed, as opposed to distributed along a continuum, as Kinsey et al. argued (2015, 1379). Sanders et al. argue that most men rate themselves as predominately heterosexual (a Kinsey 0–1) or as homosexual (5–6) (2015, 1379). However, making the claim that most men rate themselves bimodally does not lead us to the conclusion that a Kinsey 0 and 1 fall under the category of heterosexuality, or that a Kinsey 5 and 6 fall under the category of homosexuality. If most men rate themselves as a Kinsey 0–1 or a Kinsey 5–6, all this tells us is that sexual orientation in men tends to be distributed bimodally, reflected at the two ends of this scale. That is, men might tend to identify as "0: exclusively heterosexual with no homosexual", "1: predominantly heterosexual, only incidentally homosexual" and, "5: predominantly homosexual, but incidentally heterosexual", "6: exclusively homosexual", but there is still an open question about whether the Kinsey's 1 & 5 are bisexual. Sanders et al.'s move to group the Kinsey 1 under the category of heterosexuality, and the Kinsey 5 under the category of homosexuality, does not make them so. On the contrary, if it turns out that we'd be better off grouping the Kinsey 1's and 5's as part of the bisexuality group, then Sander's et al. would be making a categorisation error. That is, they would be erroneously studying the wrong group of people.

Furthermore, it is unclear how these markers 'add up' to classify sexual orientation or how the study participant's self-identification matched up with the available Kinsey scale options (0–6).

A one-factor account (sexual behaviour)

Lastly, consider a study that is, at the time of writing this paper, claimed to be the largest genome-wide analysis of sexual orientation. According to Ganna et al. in 2018, 'Twin and family studies have shown that sexual orientation is in part genetically influenced (~40% narrow-sense heritability), but previous efforts to identify

the specific genes involved have been unsuccessful due to a lack of power' (2018). Ganna et al.'s (2019a) study is supposed to fill in this deficit; with ~ 500,000 participants, it is supposed to address the lack of power problem that affected previous studies. In this newer study, sexual orientation is mostly[7] understood in terms of sexual behaviour:

> 'Our primary phenotype of interest is a binary, self-reported measure of whether respondents had ever had sex with someone of the same sex (here termed "nonheterosexuals") or had not (here termed "heterosexuals")' (2019a, 1).

One problem is that Ganna et al. (2019a) use different sexual orientation markers from the ones used in previous studies that their research is supposed to be improving upon (improving the lack of power, more specifically). Sanders et al. (2017), for example, did not employ sexual behaviour as a classifier in their study. While Sanders et al. (2017) understand sexual orientation through self-identification and sexual feelings, Ganna et al. (2019a) mostly understand sexual orientation through sexual behaviour. The conclusions drawn about *what it is* that is influenced by genetic differences are different, and this is obscured by the fact that they both refer to different things as 'sexual orientation'.

Importantly, however, there are also serious difficulties internal to Ganna et. al's classification scheme. While Ganna et al. mainly classify sexual orientation in terms of sexual behaviour, they use six additional sexual orientation markers in their study. My aim is to highlight just how problematic these other six sexual orientation markers are. There are too many problems with the ways in which Ganna et al. collected and assessed this data for it to be useful for their study.

Ganna et al.'s dataset of nearly 500,000 individuals was created by combining the genetic records of several subsidiary data sets, notably a huge repository of UK Biobank information, and a substantial dataset of 23andMe users. These two main groups of study participants were asked different questions to assess and classify their sexual orientations. The first, and largest, group of participants were 408,995 individuals whose genetic information was drawn from UK Biobank data. These participants were asked only about their sexual behaviour. The second main group were 68,527 individuals whose genetic information was compiled in a 23andMe dataset. The 23andMe group of study participants were asked seven questions (including a question about sexual behaviour, albeit not the same questions that were put to UK Biobank participants) to assess their sexual orientation. The questions for the 23andMe group were questions about their sexual identity, sexual attraction,

[7] Ganna et al. discuss other sexual orientation markers in their study such as sexual identity, sexual attraction, sexual experience, sexual fantasies, gender and emotional connection, gender and socialization, and gender and time spent/comfort. However, these markers were only used to assess the sexual orientation of 23andMe study participants (the smallest set of participants), but not used to assess the sexual orientation of all study participants, including their UK Biobank participants. This creates a lot of difficulties for their overall conclusions, which I will address later on in this paper.

sexual experience, sexual fantasies, gender and emotional connection, gender and socialisation, and their gender and time spent/comfort.[8] (2019b, 6–7).

Ganna et al. combined both of these groups to form one large dataset that they then used to test for genetic markers. Combining the groups in this way might be legitimate if both of these groups had their sexual orientation assessed in the same way. But in fact, they had not.[9]

For example, the UK Biobank study participants were asked: 'Have you ever had sexual intercourse with someone of the same-sex?' (2019b, 4). After answering this question, the study participants answered two further questions that determined whether they were exclusively homosexual or heterosexual: ''About how many sexual partners have you had in your lifetime?' and 'How many sexual partners of the same sex have you had in your lifetime?'' (2019b, 4). In order to be considered an 'exclusive homosexual', the study participants had to answer yes to the first question. Additionally, the number of same-sex partners had to be equal to the total number of sexual partners reported:

> 'Participants that responded affirmative to this question and for which their total number of same-sex sexual partners was equal or greater (sic) to their total number of sexual partners were considered exclusively homosexual, whereas those who never had sex with a same-sex partner were considered heterosexual. Participants that reported to have never had a sexual relationship and those with both same-sex and opposite-sex sexual partners were set to missing'[10] (2019b, 4–5).

Those study participants that never had a same-sex partner were labelled 'heterosexual'.

In contrast, the participants from the 23andMe group were assessed quite differently. The participants were asked 'With whom have you actually had sex?' and then had seven options from which to choose.

(0) other sex only,
(1) other sex mostly,
(2) other sex somewhat more,
(3) both sexes equally,
(4) same sex somewhat more,
(5) same sex mostly, and
(6) same sex only,

Ganna et al. reassessed this information '[…] with participants who answered 0 (other sex only) being considered as heterosexuals and those who answered 1 (other

[8] This question aimed to find out 1) what community the study participants liked to spend their time with and 2) what community they felt more comfortable in (Ganna et al. 2019b, 6–7).

[9] This means that despite Ganna et al.'s best efforts to "translate" both of these datasets to form one dataset, they did not "translate" these datasets successfully.

[10] Excluded from the study.

sex mostly) to 6 (same-sex only) as non-heterosexuals' (2019b, 7). This means that in the case of 23andMe study participants, it only took 1 same-sex sexual encountered to count as a 'homosexual', while the UK Biobank study participants required that the number of their same-sex partners be equal to the total amount of their sexual partners.

There is an important methodological question here about their "1 same-sex sexual encounter classifies a person as homosexual" rule applied to the 23andMe cohort. It is not clear why, for example, this doesn't work the other way around, where 1 opposite-sex encounter would classify a person as heterosexual. There are many worrying parallels between the sexual orientation methodology used here by Ganna et al. and the "one drop" rule used for race.[11] It's not clear why heterosexuality is considered the default in here. If they had used an opposite 'one other-sex sexual encounter' rule, the number of individuals classified as 'homosexual' and 'heterosexual' would have been different. The group classified as 'homosexual' would have been 3,182 and not 13,283.[12] And for the group classified as 'heterosexual', the number would have been 67,491 and not 57,390.

It is also unclear why people that reported having both experiences were not classified as bisexual, or with a more fitting sexual orientation category.[13] Had study participants that reported anywhere from a 2 to a 6 been classified as bisexual, the numbers of 'homosexuals' and 'heterosexuals' would have also been different. The number of individuals classified as 'heterosexual' would have been 57,390, the number of individuals classified as 'bisexual' would have been 10,101, and the number of individuals classified as 'homosexual' would have been 3,182.

Despite this inconsistency in classifying sexual orientation, Ganna et al. treated the data collected from both groups as a single dataset. The problem with this is that if they had used only one set of criteria for classifying sexual orientation across the entire cohort of ~ 500,000 participants, the results would have been different. For example, by applying the 'one same-sex sexual encounter' rule to the UK Biobank study participants, the number of individuals classified as 'homosexual' in this group would have been 15,847 and not 2,459. If Ganna et al. wanted to be consistent, they could have used their 'exclusively homosexual' (total same-sex sexual partners = total sexual partners) criterion on the 23andMe data. The result would have been that 3,182 instead of 12,933 participants would have been classified as 'homosexual'. This shows that 1) depending on which rule Ganna et al. use, the category of 'homosexual' will have different populations and 2) that there is a problem with Ganna et al.'s classificatory system. It is a mistake to combine two datasets that are using two non-equivalent rules into one dataset.

[11] This rule states that one drop of Black blood makes a person Black. For more on this problematic rule and its history, please see (Blay, 2021).

[12] There is a discrepancy of around 2,146 between the data that was collected by Ganna et al. and the numbers that were reported after 'related individuals' were removed from the data. My analysis focuses on the data reported in table S3 of the supplementary material (2019b, 40).

[13] Or excluded from the study, as was the case in the UK Biobank cohort.

A further problem is that the study participants from the 23andMe group were asked very different questions about their self-identification compared with how Ganna et al. understand and report this information. 23andMe asked the study participants 'How do you label, identify, or think of yourself?' (2019b, 42). The study participants then had seven options from which to choose as their answer: 1) heterosexual only, 2) heterosexual mostly, 3) heterosexual somewhat, 4) bisexual, 5) homosexual somewhat more, 6) homosexual mostly, 7) homosexual only (2019b, 42).[14]

But Ganna et al. ignore this information about self-identification. Instead, the authors classified anyone who had ever engaged in same-sex behaviour in some of their tests as 'nonheterosexual' and anyone who had never engaged in same-sex behaviour but only opposite-sex behaviour as 'heterosexual'. As such, participants' self-identification of their sexual orientation is swept aside, to be replaced with a classification based on their sexual behaviour. It is deeply problematic to identify a person's sexual orientation with their sexual behaviour because sexual behaviour is heavily dependent on a person's social and political context. It is an elementary mistake to classify anyone who has ever engaged in same-sex sexual activity as a 'nonheterosexual', especially if this also involves ignoring their self-identification as heterosexual, since it is perfectly conceivable that someone can have a same-sex sexual encounter and still be heterosexual. Such same-sex sexual encounters can be accounted for in many ways. Perhaps the person in question had that same-sex sexual encounter while sexually experimenting in their early adulthood, perhaps while working as a sex worker, or perhaps while being part of a community with limited partner options, such as the military. An account that simply ignores self-identification in this way is not able to account for these obvious kinds of complexities.

Additionally, 'nonheterosexual' is not a popular sexual orientation concept used outside of these studies. While Ganna et al. worry that a term like this might be offensive (it is), their actual problems (which they do not address) are that: 1) 'nonheterosexual' is not a sexual orientation concept, but instead is something like a compliment to the concept of sexual orientation. For example, while red is a colour, non-red is not. Non-red is just red's compliment. 2) 'nonheterosexual' is not a unified or coherent category. Consider the colour red example again. The group of colours that are non-red would include colours like blue, green, etc. In this sense, non-red seems incoherent as a single group classifier. This is because the differences between some of these colours seems greater than anything that they have in common. 3) 'nonheterosexual' is not a concept that anyone uses in connection with thinking or talking about their own or other people's sexual orientation. If Ganna et al. want to study sexual orientation, then they need to use

[14] A scale like this is problematic because some of these concepts are not popular self-identifications of sexual orientation outside of surveys like this. It is unclear what 'heterosexual somewhat' is supposed to refer to here and it is also quite uncommon for someone outside of these studies to self-identity as 'heterosexual somewhat'. It is unclear what the difference or relationship between 'heterosexual somewhat' and 'bisexual' is supposed to be, for example, or between 'homosexual somewhat more', 'bisexual', and 'homosexual mostly'.

sexual orientation concepts that are coherent and used in the actual social context in which their study participants find themselves.

Furthermore, the self-identification information collected by 23andMe was used to test for phenotypic and genetic correlations between this and the other six markers (sexual attraction, sexual experience, sexual fantasies, gender and emotional connection, gender and socialisation, and gender and time spent/comfort). Although there appears to be a high correlation between sexual experience and sexual identity (self-identification) when looking at the graphs provided by Ganna et al. (2019b, 36), it is unclear how self-identification was assessed for this test. It is unclear if Ganna et al. applied the same one-person rule, where all it takes is for a study participant to report one same-sex sexual encounter to be classed as a 'nonheterosexual' or whether they actually honoured the seven-point scale: (1) heterosexual only, 2) heterosexual mostly, 3) heterosexual somewhat, 4) bisexual, 5) homosexual somewhat more, 6) homosexual mostly, 7) homosexual only). In the supplementary material, Ganna et al. report that for the 23andMe data set 'The sexual experience question (item 3) was transformed into a dichotomous variable (to be consistent with the dichotomous variable from UK Biobank) and analyzed as the main phenotype, with participants who answered 0 (other sex only) being considered as heterosexuals and those who answered 1 (other sex mostly) to 6 (same-sex only) as non-heterosexuals' (2019b, 7).

The trouble here is that by applying the 'one person' rule, the interpretative 'transformation' given by Ganna et al. is no longer a reflection of how the study participants actually self-identified: it is literally not the case that participants identified themselves using these categories.

But note that if Ganna et al. tried to use 23andME's seven-point self-identification system, this would also have presented two different problems. The first is that these seven self-identification options are a distinct way of classifying sexual orientation from the classificatory method used in the rest of the tests carried out within the study, where Ganna et al. label their study participants as 'nonheterosexuals' and 'heterosexuals'. This means that even within their own study, Ganna et al. appear to be talking about different kinds of things (concepts with different extensions); this seven-point scale and the one-rule method are not the same kind of thing.

The second problem is that it is unclear just how much these seven self-identification options actually reflect how anyone is thinking about or talking about their own or other people's sexual orientation. This point is important to highlight again because the claim by Ganna et al. in the above-mentioned test is that there is a phenotypic and genetic correlation between how people self-identify and their sexual behaviour. But if no one uses, or encounters, or thinks, about the seven-point scale when thinking about sexual orientation, then asking people to report one of the seven options on this scale that matches their sexual orientation does not mean that the answer they select from these seven options will count as a genuine act of self-identifying their sexual orientation. This is because they will just be engaging with

Table 1 A recap of the sexual orientation concepts used in the four genetics studies

Authors	Sexual orientation markers used
Hamer et al.	Self-Identification, attraction, fantasy, and behaviour
Rice et al.	Self-identification,corroboration from secondary sources, and stereotypes
Sanders et al.	Self-identification and sexual feelings
Ganna et al.	Mostly sexual behaviour (to see the rest of these markers, please see §2.4)

the question they have been asked and will answer based on the list of options they have been given.[15]

Inconsistent uses of sexual orientation markers

In §2, I catalogued four genetic studies and have shown that they all seem to understand sexual orientation differently and some, very problematically. Here is a table with a recap of how each of these studies understand sexual orientation: (Table 1).

There is no 'one' marker of sexual orientation that these *four* studies all use in identifying sexual orientation. There is, however, one marker that *three* of these studies use. That marker is self-identification. But even then, all of these studies use different measures of self-identification. In this section, I argue that the inconsistent use of sexual orientation markers in genetic studies is a problem.

It is problematic that geneticists are currently using an inconsistent variety of sexual orientation markers in the genetics literature of sexual orientation because this could lead to different and potentially conflicting results. Recall that Ganna et al. understood and classified sexual orientation mostly in terms of sexual behaviour, and that they took their study to build upon the genetic research of sexual orientation that has been previously carried out, although in much smaller numbers. I argue that it is highly improbable that Ganna et al.'s study builds upon the results of previous genetic studies. This is because previous studies are talking about different things. Consider the study carried out by Sanders et al., for example. According to them, sexual orientation was identified on the basis of two sexual orientation markers: sexual identity and sexual feelings. These markers are different from the sexual behaviour marker that Ganna et al. are focusing on. To illustrate this point, consider the case of Sam. Sam is a gay man who has only recently come out and has only ever sexually engaged with women. If Sam was a study participant in Sanders et al.'s study he would be identified as a gay man (because of his self-Id). However, if Sam was a study participant in Ganna et al.'s study, Sam would potentially be identified as a heterosexual man (due to his sexual history). I argue that the reason Sam is able

[15] Given that Ganna et al. take their results to improve upon previous genetic studies, they also face the glaring problem that none of these earlier geneticists account for self-identification using this seven-point scale, nor using the heterosexual/nonheterosexual classifiers. They use sexual-orientation concepts such as gay, lesbian, and heterosexual.

Table 2 A visualisation of the different concept extensions

Authors	Sexual orientation markers used	Sam's sexual orientation
Hamer et al.	Self-Identification, attraction, fantasy, and behaviour	Bisexual man (depending on how much weight we give each of these markers)
Rice et al.	Self-identification, corroboration from secondary sources, and stereotypes	Gay man (depending on how much weight we give each of these markers and depending on what others make of Sam's sexual orientation)
Sanders et al.	Self-identification and sexual feelings	Gay man
Ganna et al.	Mostly sexual behaviour (to see the rest of these markers, please see §2.4)	Heterosexual man

to end up with a different sexual orientation in each of these studies is because these geneticists are not talking about the same thing (they are talking about concepts with different extensions) when talking about sexual orientation.

For a visualisation of this argument, please see the below table. (Table 2).

This has the consequence that the predictive and explanatory power of these studies is then reduced to whatever it is that they are measuring individually and in that specific context. This is in contrast to what they aim and take themselves to be doing, which is providing a larger-scale project. For example, while Ganna et al.'s study might be able draw some interesting conclusions from their data on sexual behaviour, any predictions or explanations resulting from these conclusions would only apply to the cultural context in which they collected their data or to a similar context. Perhaps they can, based on their data, make some predictions and explain sexual behaviour patterns (but not sexual orientation) based on the data that they produced and only in relation to that specific context. For example, their study participants were from the UK, the U.S., and Sweden. My thought here is that their results would only apply to these contexts and perhaps to other similar contexts. This is because sexual behaviour is heavily dependent on a person's social and political context. The UK, the U.S., and Sweden are all countries that afford the LGBTQI + community with greater rights and liberties than say, places like Sudan, Iran, Saudi Arabia, or Yemen, where homosexuality is criminalised, and in some places punishable by death. It is not difficult to imagine that LGBTQI + people that live in places where homosexuality is punishable by death might not engage in the sexual behaviour that best reflects their sexual orientation. In fact, it is quite likely that many of these LGBTQI + people are engaging in sexual behaviour that does not reflect their actual sexual orientation. This is just one example of how sexual behaviour can change from context to context, due not to a person's sexual orientation, but due to that person's social and political context.

Self-identification

So far, I have critically engaged with four genetic studies and shown 1) that they use different sexual orientation markers and 2) that this can lead to different and conflicting results. In this section, I argue that it is undesirable for scientists to adopt the self-identification view of sexual orientation on its own.

The self-identification view of sexual orientation is the view that sexual orientation '[…] is based on one's sense of what his or her own sexual orientation is´ (Stein 2001, 44). This is the view that if person X really believes that they have a q sexual orientation, then that is their sexual orientation. This seems like a pretty straightforward way to understand sexual orientation and in fact, many areas of research successfully employ this understanding to their studies. For example, if we want to find out if there are any wage gaps between say, lesbian women and heterosexual women, then it makes sense that when collecting information from study participants, that we collect sexual orientation information based on how the study participants self-identify.

For example, in 'Sexual Orientation, Labour Earnings, and Household Income in Canada'(2018), information about the study participants' sexual orientation was collected through a self-report by the study participants. Studies like Dilmaghani's do not aim to find an underlying mechanism that is responsible for what makes someone gay or heterosexual. They aim to find out whether there are any income differences between groups of people that already self-identify with a particular sexual orientation. In contrast, genetic studies aim to find an underlying mechanism that is responsible for sexual orientation. The difference in research aims helps explain why the self-identification view of sexual orientation might be useful for economical and statistical studies like Dilmaghani's study, but not useful for genetic studies. To illustrate this idea, consider the case of political lesbianism.

Political lesbianism, just as the name suggests, is a political movement that aims to challenge male supremacy by prioritising women. For some women, part of this prioritisation includes exclusively engaging romantically and/or sexually with other women. Political lesbianism is a political identity that has been intentionally taken up and self-consciously adopted as an act of political choice by (previously) self-described heterosexual, bisexual, and lesbian women. In contrast, there are self-described lesbians that were lesbians long before committing to a political lesbian identity, whom took the concept of lesbian to describe their sexual desires, attraction, fantasies, etc., regardless of their political commitments. My point here is that self-identification and inner states and processes can come apart. The first might describe a political identity, while the latter might describe desires, attraction, fantasies, etc.

In the Canadian Household Income study, it makes sense that political lesbians should be understood as lesbians because it does not matter whether or not their sexual desires, attraction, fantasies, etc. line up with their self-identification. It matters that socially, they are subject to the same kind of injustices as lesbians whose desires, attraction, fantasies, etc. do align with their self-identification. For example, if two political lesbians are known to be in a relationship, then they will be subject to the same kind of wage discrimination that other lesbians face. For this reason, it is important that they be considered lesbians in studies such as the Canadian Household Income study. In contrast to economic and statistical studies like the Canadian Household Income study, genetic studies aim to find an underlying mechanism for sexual orientation. These geneticists will not want to include people who identify as lesbians for political reasons. This is because it seems that what geneticists aim to uncover is something deeper about sexual orientation. I argue that this 'something deeper' (if there is such a thing) will have to do with a person's internal states such as sexual desire, attraction, fantasy, etc. towards a person, at least partly on the basis of that person's sex.[16] Put a different way, a political lesbian is more likely to desire and fantasise about men, while a lesbian (who is not a lesbian solely because of their political commitments) is less likely to. For this reason, I do not think that a

[16] Much more work is needed on how to properly incorporate gender to discussions of sexual orientation, but this is a larger project for another paper. For the purposes of this paper, I am following the literature and focusing on sex, trying to make incremental progress.

self-identification view is enough to carry out the job in the context of genetic studies. Geneticists need something else *in addition* to a person's self-identification that will aid them in identifying an underlying mechanism for sexual orientation (if it turns out that there is one). Later in this paper, I argue that that something is a person's self-report of their sexual desire, attraction, and fantasy. That is, I argue that geneticists should focus not only on self-identification, but also on inner states and processes, and that these two markers should line up.

The problem with behaviour views of sexual orientation

In this section, I argue that behaviour is the least reliable indicator of sexual orientation and that it is undesirable for scientists to adopt this view in any form or combination.[17] If scientists are right, and there is some kind of genetic basis for sexual orientation, then this will most likely be explained in terms of some kind of mechanism(s). If it turns out that there is a mechanism(s), then behaviour will just end up being some kind of consequence of this mechanism(s), but only in some cases (for example, some people will act on these desires and fantasies and as a result engage in sexual behaviour, but others will not).

In its most radical version, behaviourism is the thesis that behaviour can be explained without reference to inner activity or processes. In the context of the sexual orientation literature, this means that sexual orientation can be understood and accounted for in terms of sexual behaviour, without any reference to inner activity or processes. This means that a person A's sexual orientation will be whatever their sexual behaviour amounts to (Stein 2001). For example, if a woman has only ever had sex with women, then she would be classified as a lesbian, according to a behaviourist account of sexual orientation.

There is, however, something strange about adopting this kind of view, or versions of this kind of view, when the aim of genetic studies is to find some kind of genetic influence or mechanism. This influence or mechanism[s] (if it turns out that there is one) will be one that shows the complex biological low-level ways in which sexual orientation is genetically influenced. Strictly speaking, it is not clear what sexual behaviour has to do with this mechanism. Sexual behaviour is a very unreliable marker of sexual orientation, if not the most unreliable of all. This is because there are many other variables (aside from the possible genetic underlying mechanism) that might play a role in whether or not someone chooses to engage in sexual behaviour. For example, someone might live in a social context in which homosexuality is criminalised and might, therefore, choose not to engage in sexual behaviour. In §3, I argued that studies that employ the sexual behaviour measure, such as Ganna et al.'s, are limited in their explanatory power because sexual behaviour is dependent

[17] In §2, I discussed Hamer et al.'s four-factor account which included sexual behaviour and Ganna et al.'s one-factor account which also included sexual behaviour. In addition to these studies, there are other studies that include sexual behaviour as an indicator of sexual orientation. For some examples, please see (Bocklandt et al. 2006; Hu et al. 1995; Mustanski et al. 2005).

on the social and political context. My point here is not to suggest that geneticists should extend, or do more, cross-cultural studies to address their sample limitations. Rather, my point is that there is no meaningful behavioural measure of sexual orientation in countries that restrict, prohibit, or punish, homosexual behaviour. Moreover, there are still homophobic social pressures in countries like the UK or Sweden, especially in conservative religious subgroups such as fundamentalist Christians. So even in these countries behaviour is a flawed measure. This presents a problem for geneticists because this means that sexual behaviour (at least in those contexts) will not be indicative of a person's sexual orientation. This shows that the very idea of using sexual behaviour as a generalised measure of sexual orientation involves a category mistake. Geneticists such as Ganna et al. that make use of behavioural proxies for sexual orientation make this same category mistake.

Some geneticists might object to this line of reasoning and argue that despite these problems, a behaviourist understanding of sexual orientation can be saved. The thought might be that this can be accomplished if we exclude all of the problematic cases where a person's sexual behaviour does not reflect their actual sexual orientation, and we only include cases where sexual behaviour is reflective of a person's sexual orientation. Although this might seem like an intuitive move, I argue that geneticists should not opt for this option.

In the philosophical literature, many philosophers have moved away from talking about 'actual' behaviour to talking about 'potential' behaviour that might manifest under 'certain conditions'. The thought is that moving away from talking about actual behaviour to potential behaviour which might manifest only under a particular set of conditions, gets rid of the problem of including a person's sexual behaviour that might not be reflective of the person's sexual orientation. This way of understanding sexual orientation is usually cashed out in terms of dispositions. For example, under a particular set of conditions a glass might break, water might boil, or a person might behave generously. With sexual orientation, the idea is that given a particular set of conditions, a person might engage in sexual behaviour and that this sexual behaviour would then be reflective of this person's actual sexual orientation.

Dispositions are sometimes understood in relation to possible worlds.[18] Possible worlds are different from the actual world. For example, in the actual world FIFA (The Fédération Internationale de Football Association) pays women's teams significantly less[19] than men's teams who take part in the world cup. In a different world, if we didn't live in a patriarchy, the women's teams would receive equal pay. In this example, the condition for the women's team to receive equal pay in our possible world is that there be no patriarchy. A possible world, then, can be understood as a place in which possible events might take place, given a certain set of conditions. For sexual orientation, this means that what is taken into account under

[18] In what follows, I engage with possible-world semantics because this is the mainstream approach in the sexual orientation literature.

[19] In the last women's world cup (2019), the winning team received a total amount of £3.2 million, while the winning men's team received a total of £310 million.

a dispositional view is not the actual behaviour that takes place in the actual world, but the behaviour that could take place in a possible world, under a certain set of conditions.

Currently, geneticists that understand sexual orientation in terms of sexual behaviour only consider behaviour that has taken place in the actual world and, as such, they ask their study participants about their actual sexual behaviour. For example, in the UK Biobank data set used in Ganna et al.'s study, participants were asked questions such as: 'About how many sexual partners have you had in your lifetime?', and 'How many sexual partners of the same sex have you had in your lifetime?'' (2019b, 4). These questions were about the actual sexual behaviour that study participants have had in this actual world. This way of understanding sexual orientation is problematic because it fails to take into account the many ways in which sexual behaviour might not be reflective of the study participant's actual sexual orientation. For example, someone might have sexually experimented during their early adult years, worked as a sex worker (part or all of their life), lived in a social and political context that meant they couldn't engage in the sexual behaviour that best reflects their actual sexual orientation, etc.

Alternatively, if geneticists were to adopt a possible-world dispositional view,[20] they would be asking their study participants not what actual behaviour they have engaged in, but what behaviour they might possibly engage in, given a certain set of conditions. For example, if geneticists wanted to capture what sexual behaviour a person that currently lives in a context where homosexuality is punishable by death would engage in if they lived in a possible world where homosexuality was not criminalised, then one of the conditions they might add would be a condition that reflects this. For example, this condition might say something like 'that there is sexual freedom in this possible world'. However, someone might object and say that this condition is not enough because in addition to needing sexual freedom, a person would also need a context in which there is a variety of sexual partners available. Therefore, geneticists might decide to include this as a condition as well, and so on. They could keep on adding more conditions, until they feel like they've arrived at a dispositional account that captures a satisfactory understanding of sexual orientation.

In theory, dispositional views of sexual orientation might seem like a good idea, but in scientific practice, geneticists face the problem of having to find a way to (imaginatively) transport their study participants to possible worlds to see what possible sexual behaviours they might engage in so that they can then record this information for their genetic studies[21][21] However, it is unclear how geneticists can achieve this.

A dispositional view would require study participants to be able to accurately imagine what it would be like to be in one of these possible worlds, which can be problematic. Take for example a person who has grown up in a social and political context where homosexuality is criminalised. Let's call this person Joe. Joe has

[20] As some philosophers have proposed (Stein 2001; Dembroff 2016; Díaz-León n.d.).

[21] In addition to this, it is well documented that people are often not reliable indicators of their attitudes or predictors of their actions (Webb & Sheeran 2006; Bar-Anan et al. 2010; Sheeran & Webb 2016).

same-sex sexual desires, but is convinced that engaging in same-sex sexual behaviour is wrong in this, and in any, possible world. Asking Joe to imagine what behaviour they would engage in in a possible world where they would be able to freely express their sexual desires would not be very helpful for geneticists. This is because Joe already believes that same-sex sexual behaviour would be wrong in any possible world. Joe's case is not an extreme case. A person does not have to live in a place where homosexuality is criminalised in order to believe that same-sex sexual behaviour is wrong. A person could have grown up in a place where homosexuality is not criminalised (like the U.S. or the UK) and still believe that same-sex sexual behaviour is wrong. The problem for geneticists is that they have to trust that their study participants would be able to imagine possible worlds that are quite different from the actual worlds they actually live in.

Towards a new understanding of sexual orientation

Instead of appealing to behaviour (including plain behaviourist views or fancier dispositions-to-behaviour views) to understand sexual orientation, I propose that geneticists should appeal to inner states or processes such as sexual desire, attraction, and/or fantasies (some of the studies I discussed in §2 use a self-report of a couple of these measures) plus self-identification, and that these two markers should line up. This proposal does not aim to capture an ultimate notion of sexual orientation. It aims to propose a notion of sexual orientation that can serve as the best fallible guide for ascribing sexual orientation in genetics.

I also do not aim to propose a specific account of sexual desire, attraction, and/or fantasy in this paper. Nor do I propose that it is these states, and only these states, that geneticists should take into account. Rather, one of the things I aim to do here is argue in favour of the idea that geneticists should move away from accounts that include sexual behaviour as an indicator of sexual orientation to ones that are concerned with inner states, or processes plus self-identification. This is because I think that these will be more reliable markers of sexual orientation and will therefore be more helpful in trying to find an underlying mechanism[s] of sexual orientation (if it turns out that there is one).

Esa Díaz-León offers an interesting alternative to how we should understand sexual orientation. According to Díaz-León, we should understand sexual orientation in terms of sexual preferences. According to Díaz-León, 'preferences' are dispositional mental states. A 'sexual preference' is a '[…] disposition to have sexual desires of certain kinds, given certain manifesting conditions' (Díaz-León n.d., 14). Sexual desire is mental state that is connected to sexual arousal: '[…] sexual desire is a mental state that is somehow connected with some experiences such as sexual arousal (which is typically correlated with the physiological state of arousal but is not identical to it)' (Díaz-León n.d., 16). This leaves open the possibility that that sexual arousal could also manifest as a psychological state. The connection between sexual desire and sexual arousal results in a hybrid view of sexual orientation. According to Díaz-León, '[…] A sexual desire (for men and/or women, or people of certain sex and/or gender) involves the combination of a propositional attitude (of

the form "S bears the relation of desiring towards proposition p") plus a disposition to be sexually aroused by, or sexually attracted to, men and/or women.' (Díaz-León n.d., 17). In this sense, her view of sexual orientation combines complex mental states (sexual desires) that involve a propositional attitude which require that a person be disposed to be sexually aroused (might be physiologically but also just psychologically) about certain kinds of people (or as she also leaves open as a possibility: caused by certain kinds of people).

There are a few things to note here. The first is that her proposal appeals to dispositions, which I find unhelpful when thinking about sexual orientation for the reasons I have discussed in §5. For these reasons, I do not think it is a good idea to appeal to dispositions, even when appealing to complex mental states such as sexual desires. Díaz-León's proposal is one that argues that we should understand sexual orientation in terms of dispositions to certain kinds of desire. My proposal would be to keep her focus on desires, but drop her focus on dispositions. I think that geneticists should move towards understandings of sexual orientation that concern inner states or processes, such as sexual desire. Díaz-León's desire view is just one example of how this view might look.

In this paper, I will not go into the technical details of Díaz-León's view because this is not my aim. My aim in this paper is to give one example of how a desire view might look and what kind of understanding of sexual orientation geneticists should start to move towards.

I propose that whatever desire view geneticists adopt, it should be one without dispositions. Some philosophers, including Díaz-León, will object and argue that without dispositions, a desire view will be subject to a lot of the same problems associated with a behaviourist view of sexual orientation because desires, just like behaviour, are influenced by other mental states as well as by a person's social and political context. For example, it could be the case that a person's homophobic social and political context will influence that person's sexual desire to the extent that they repress their sexual desires. I think this is a worry, but to a lesser extent than it is for a behaviourist view.

Like Stein (2001), I think that this objection actually offers a great explanation as to why it sometimes takes LGBTQI + people such a long time to come out to themselves, or to come to terms with their sexual orientation. The difference between behaviour and desire is that once people come out with a particular sexual orientation, they are much more likely to hold on to these sexual desires as a reflection of their actual sexual orientation than they are with their sexual behaviour. In many cases, this is due to the pressures from one's social and political context. For example, a gay man living in a country where homosexuality is punishable by death might still hold his sexual desire towards other men as a reflection of his actual sexual orientation, even though he might not be able to engage in sexual behaviour that reflects his sexual orientation with other men due to his social and political context. Because of this, I think that the way forward for geneticists is to move towards some kind of internalist view.

Earlier in the paper, I argued that self-identification alone was not enough to understand sexual orientation. This was because self-identification can oftentimes be used for purely political reasons (as in the case of political lesbians). I argued that what

geneticists were actually after seemed to be something deeper (something more) than political reasons and that this something deeper were inner states and processes. I argued that the problem with self-identification was that it was not sufficient on its own because it was not able to capture this 'something deeper'. However, when inner states and processes such as desires are combined with self-identification, this is no longer a problem. This is because in such cases self-identification is not just a reflection of a person's political commitments, it is also a reflection of that something deeper. If we think that that something deeper are desires, then self-identification would, in part, be a reflection of those desires. In practice, this means that study participants in genetic studies would self-report their desires (according to the view that geneticists adopt) as well as their self-identification, and these two things would need to line up.

Of course, one can imagine scenarios where self-identification and self-report of inner states and processes might not line up. For example, a person with internalised homophobia might self-identify as heterosexual, despite reporting same-sex attractions. In these cases, these individuals would be filtered out of genetic studies because their self-identification and self-report of inner states and processes would not line up. Some political lesbians, to come back to this example, would also be filtered out of genetic studies because their self-identification and inner states and practices would also not line up. To be clear, this does not mean that these individuals would not have a sexual orientation. This is because the aim of my proposal is not to capture an 'ultimate and infallible' notion of sexual orientation. The aim of my proposal is to put forward the best fallible guide for the purposes of ascribing sexual orientation in genetics.

Another possible worry about this two-marker proposal, is whether inner states and processes can do the job on their own as a one-marker classificatory system of sexual orientation (that is, without self-identification). I argue that it cannot. Self-identification plays an important role when it comes to classifying sexual orientation. This is because, on their own, inner states and processes might not be reflective of a person's sexual orientation. Take for example, same-sex environments, such as same-sex boarding schools, where due to the lack of available partners and/or due to experimentation, some people in these contexts will end up desiring the partners that are available in these contexts. Importantly, however, these desires might not be a reflection of their actual sexual orientation. This is because in some cases, these desires will be a consequence of the lack of available partners or of experimentation. This example shows that the self-report of a person's inner states and processes, such as desires, won't always be a reflection of one's sexual orientation. This is why desires (or any other inner states and processes) on their own are not enough to ascribe sexual orientation. This also shows why the self-identification of a person's own sexual orientation, in combination with inner states and process, is important when ascribing sexual orientation.

Conclusions

To circle back to the quote I started off with, I do not think there is empirical evidence available to support (or reject) Hamer's claim that '[…] genes are the single most important factor in determining a person's sexual orientation and outweigh all

known shared environmental factors' (Hamer 2013). Even though there are genetic studies of sexual orientation published on this topic, I have argued that these studies are far from being able to support, or reject, a claim like Hamer's because of the different, and oftentimes problematic, understandings of sexual orientation that these studies adopt. What is needed in order to be in a position to assess Hamer's claim is a consistent and operational understanding of sexual orientation.

To this end, I proposed that geneticists should adopt an inner state like understanding of sexual orientation that includes self-identification as an important marker of sexual orientation. My aim in this paper was to (1) offer a convincing argument for the use of uniform understandings of sexual orientation across all genetic studies of sexual orientation, (2) to argue that the best way forward for such studies is to adopt a view of sexual orientation that includes inner states or processes plus self-identification and requires that these two markers align.

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