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Human Sexuality from A to Z: Notation, Modelling, and Explanation

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Abstract

It is the aim of this article to introduce a concise notation that is be able to capture the most important dimensions of sexuality and thus facilitate discussions. Moreover, the major three dimensions - sex, gender, and sexual orientation - lead to a straightforward classification which motivates the quest for stringent explanatory models, some of which are also discussed.

Keywords: Human Sexuality, Sexual Development, Relevant Factors, Parsimonious Model, Classification, Notation

Introduction

Human sexuality has many facets. Consistently, countless terms have been invented to describe and specify it. Alas, despite all efforts, communication has not become less difficult in the field, since concepts are often rather vague, may change their meaning, or have been loaded with value judgement. Inevitably, received verbal descriptions and explanations are built on rather shaky ground.

Compare this to the state of affairs in other sciences. Instead of lengthy verbal arguments, revolving around innumerable phenomena, the Standard Model of particle physics, the Periodic Table of the Elements, and Linne's system, to name but a few, aim at an appropriate logical structure that is able to captures the main features, stabilize scholarly efforts and motivate further research. Building on this solid foundation, they have been able to explain observations, predict outcomes and construct technical applications.

In this vein, says: "The reason for being interested in models is, however, clear. They are an imperfect but hopefully reasoned attempt to capture the essence of some aspect of the real physical, biological or social world and are in principle empirically at least partially testable. If we have a reasonably fruitful representation then in principle everybody is or should be interested in it [1]."

To this end, this article starts with three straightforward dimensions (physical, mental, and orientation), which yield a natural classification scheme that is able to capture essential facets of human sexuality. This basic model may then be extended, taking into account further relevant dimensions - social and genetic factors, in particular. Moreover, Occam's razor suggests that the most parsimonious explanation of the resulting scheme should be based on several sensitive periods that to a large extent determine our sexual disposition.

Basic Classification

Given a top-down point of view, any theory of human sexuality must take into account at least three dimensions (variables, properties):

Anatomy (Biological Sex)

Every human body has primary and secondary sexual characteristics, in particular, reproductive organs. At least traditionally (and aiming at a simple model), there are only two sexes, i.e. a body is either male or female.

Mind (Psychological Gender)

Humans also have a gender identity, i.e., some kind of basic sexual imprinting on their minds. They feel and think of themselves as either male or female.

Orientation (being attracted to. . .)
At least for the sake of reproduction, people are attracted to others. Traditionally, this is also a dichotomy: they find either men or women attractive, i.e., they are either androphile or gynophile.

Therefore, the simplest model of human sexuality consists of three dichotomous variables: body (anatomy), mind (psychology) and sexual orientation. Since any combination of these factors ($2^3 = 8$ in total) seems feasible, we have the following categories:

Table 1: Overview of Basic Classifications

No.	(1.) Body	(2.) Mind	(3.) Orientation	Comment
1	F	F	F	gynophile (homosexual) woman
2	F	F	M	androphile (heterosexual) woman
3	F	M	F	gynophile man in a woman's body
4	F	M	M	androphile man in a woman's body
5	M	F	F	gynophile woman in a man's body
6	M	F	M	androphile woman in a man's body
7	M	M	F	gynophile (heterosexual) man
8	M	M	M	androphile (homosexual) man

For example (case no. 1), a lesbian woman has a female body, feels like a woman and is attracted to women; therefore (Body, Mind, Orientation) = (F, F, F), abbreviated 'FFF', whereas a heterosexual woman (case no. 2) is attracted to the opposite sex (FFM).

A three-dimensional vector is more difficult to grasp than the following notation that may also be extended easily. Since for all practical purposes the anatomical sex (1.) is most easily observable, we write this property as a capital letter. Not directly observable are gender identity (2.) and orientation (3.). Using subscripts for the latter properties, we arrive at

$$2.1.3. = \text{mind}^{\text{body}}\,\text{orientation} \quad \text{or} \quad \text{identity}^{\text{sex}}\,\text{orientation}$$

For instance, ${}_{\text{F}}\text{F}_{\text{F}}$ corresponds to case no. 1, ${}_{\text{F}}\text{F}_{\text{M}}$ to case no. 2, etc. Note that the 'inverse' of case number 1 is case number 8, i.e., ${}_{\text{M}}\text{M}_{\text{M}}$; the inverse of case number 2 is case number 7, i.e., ${}_{\text{M}}\text{M}_{\text{F}}$, etc. The line between cases 4 and 5 in the above table also represents this symmetry.

Alternatively, and even more explicitly, one could use a line to indicate features - above that line - that are readily observable (public), and properties - below the line - that are latent (private).

$$\frac{\text{sex}}{\text{(my) gender identity} \qquad \text{sexual orientation (I am attracted by . . .)}}$$

Now it is easy to distinguish between three broad classes of sexual abberation:

Sex and Orientation
Directly observable hetero- / homosexuality depends on dimensions (1.) and (3.). That is, the capital letter and the second subscript are different or they agree, respectively. Consistently, cases 2, 4, 5, 7 (${}_{?}M_{F}$ and ${}_{?}F_{M}$) are heterosexual, physically speaking, whereas cases 1, 3, 6, 8 (${}_{?}F_{F}$ and ${}_{?}M_{M}$) are anatomically homosexual.

The question mark (?) is a so-called 'wildcard', i.e. it represents any kind of gender identity. One could also abbreviate these cases to M_F , F_M on the one hand and to F_F , M_M on the other.

Gender identity and Orientation
Consistently, psychological hetero- / homosexuality means that the subscripts (dimensions (2.) and (3.)) are different or the same, respectively. Thus cases 2, 3, 6, 7 are, psychologically speaking, heterosexual, since they differ in the second and the third dimensions.

A look at the subscripts also shows immediately that cases 1, 4, 5, 8 are psychologically homosexual, i.e., we either encounter ${}_{\text{M}}?_{\text{M}}$ or ${}_{\text{F}}?_{\text{F}}$, if the (?) here, signifies any kind of biological sex.

Gender identity and Sex
Finally, if dimensions (1.) and (2.), i.e., the capital letter and the first subscript agree, biological sex and psychological gender coincide. However, a difference between the first and the second dimensions denotes gender dysphoria, i.e., a (potential) trans-gender person (cases 3-6).

In these cases, surgery may turn cases 5 and 6 (${}_{F}M_{?}$) into ${}_{F}F_{?}$, i.e., a female, and cases 3 and 4 (${}_{M}F_{?}$) become, if treated, trans-men ${}_{M}M_{?}$. A shorter notation would be ${}_{F}M \rightarrow_{F} F$ and ${}_{M}F \rightarrow_{M} M$.

Male bodies with female gender identity (${}_{F}M$) have caused some distress in sports: If these persons are - due to their gender identity- allowed to participate in female competitions, their male bodies are often superior and may hurt athletes with female bodies (${}_{?}$F). Moreover, since gender identity is not readily observable, men (${}_{M}M$) might also be tempted to excel in women sports [2].

Be this as it may, without much effort, the social tier - which is observable, and thus 'above the line' - may also be included in this notation:

$$\frac{\text{gender (public role, social construct)} \qquad \text{orientation displayed in public}}{\text{Sex}}$$
$$\text{gender identity (personal feeling)} \qquad \text{'real' (but hidden) personal orient.}$$

Note that this extended notation puts gender on the left-hand side, and sexual orientation on the right-hand side. Moreover, public / observable features are superscripted, whereas private / latent properties are subscripted. So to speak, they are 'below the line' of direct observability.

For instance, perhaps due to social compulsion, a gay man may hide his real sexual orientation. In our notation this becomes

$$\begin{array}{ll} M & F \\ & M \\ \hline M & M \end{array}$$ or, more compactly, ${}^{M}_{M}M^{F}_{M}$, and M^{F}_{M} if gender identity is irrelevant.

Couched in words, this person submits to social norms in public - his role behaviour is male-typical and he displays some interest in women. However, his true (hidden) orientation is quite the opposite.

An openly lesbian woman would be ${}^{F}_{?}F^{F}_{?}$ (no matter what her psychological stance), or more concisely ${}^{F}F^{F}$, and it is straightforward to give further examples. For instance, following notational conventions used in chemistry, a typical couple could be denoted by ${}^{F}_{F}F^{M}_{M} - {}^{M}_{M}M^{F}_{F}$, or quite simply F − M, like a 'molecule' consisting of two atoms.

An Explanation Template

The above classification has mainly been derived by rather abstract considerations. Table 1 summarises a parsimonious framework that takes intoaccount major varieties of sexual imprinting and orientation. Its credibility would be much improved if it could be supported by similarly uncomplicated factors and mechanisms.

The most parsimonious mechanism would be a single factor with this factor's concentration (high or low) determining physiological and psychological sex and orientation during three subsequent critical periods. Pinning down a crucial factor, Phoenix et al. [3] wrote: "We are assuming that testosterone or some metabolite acts on those central nervous tissues in which patterns of sexual behavior are organized."

Taken with a pinch of salt, this hypothesis has become the most popular explanatory model (4-17).

For instance, Baum concludes that numerous studies "showed that perinatal administration of testosterone to females organized male-typical features, whereas perinatal deprivation of testosterone [resulted] in the female-typical phenotype [18]." More generally speaking, "brain organization theory posits a cascade of physiological and behavioral changes initiated and shaped by prenatal hormones" [19].

In a nutshell, testosterone and other hormones seems to 'make' (and sustain) a man, and females develop if the concentration of these sex hormones is low. In a table, the simplest model is:

Table 2: The Critical Period Model

Critical period:	1. → Sex	2. → Gender Identity	3. → Orientation
testostrone high (T)	M	M	male = gynophile (F)
testostrone low (t)	F	F	female = androphile (M)

In other words, according to this parsimonious scheme, the testosterone level is either high (T) or low (t). It is this level that, in the first critical period determines a body's sex, in the second critical period it fixes gender identity, and finally, in the third critical period, it sets a person's sexual orientation.

If in the last critical period the testosterone level is high, a male-typical orientation, i.e. being attracted to women - gynephilia - ensues, i.e., the orientation is toward women (F). However, if the testosterone level is low, a female-typical orientation is the consequence, i.e., the person becomes androphile (M). Roselli [20] summarizes the available evidence. Based on this, she conjectures that the first / second critical period occurs during the first / second trimester of pregnancy, when testosterone levels are high. The third critical period seems to occur postnatally, but rather early in life.

Biological and Mathematical Considerations

Due to combinatorial reasons, there are, again, $2^3 = 8$ possible combinations (TTT, TTt, . . ., ttt). Moreover, according to the most simple model, each of these patterns corresponds to a certain outcome displayed in Table 1 by means of T → M and t → F in phases one and two, but T → F, t → M in phase 3. For instance, hormonal levels TTt should lead to a gay man ${}_{M}M_{M}$, and hormonal levels Ttt to ${}_{F}M_{M}$, i.e., case no 6.

On purely mathematical grounds, dimensions could be independent and prevalence rates arbitrary. However, biologically, gestation periods build on each other. Therefore, deviations in early pregnancy have greater consequences than later, and several errors in gestation should have greater effects than just a single fault.

Due to these considerations, and also Darwinian selection that - at least without further sophistication - does not favour same-sex orientation (${}_{M}M_{M}$, in particular), it is to be expected that most persons fall into categories 2 and 7 (corresponding to ttt and TTT , respectively), i.e., they are 'ordinary' (straight) women and men. Directly observable homosexuality (i.e., cases 1 and 8, corresponding to ttT and TTt, respectively), probably caused by a slight deviation towards the end of pregnance or shortly afterwards, should also be relatively common. Less common should be cases 4 and 5, since they are the result of a wrong level of testosterone in the second critical period (tTt and TtT , respectively). Finally, cases 3 and 6 are anticipated to be very rare, since they would be caused by an abnormal level of testosterone during the first period (tTT and Ttt, respectively).

Unfortunately, although abundant, empirical data on this subject is rather unreliable (see, in particular, the English Wikipedia's vast and growing collection on "Demographics of sexual orientation"). Nevertheless, at the very least, existing data confirm the above reasoning: typical estimates of 'ordinary homosexuality' are at most ten percent of the population, whereas transsexual-

ism is much rarer, about five in 100,000 individuals [21]. Bailey et al. (2016) cite recent research that gives about 3% who are either gay, lesbian or bisexual [22]. It is also well-known that Blackless et al.'s (2000) number of 1.7% 'intersex' persons is exaggerated [23]. Two of these authors later corrected that number to 0.37% [24]. Using a more precise definition, Sax (2002) comes to the conclusion that 'the true prevalence of intersex is seen to be about 0.018%'[25].

More Complicated Models, Extended Notation

If we include genetics, and write X or Y for the sex chromosomes, we may easily extend the above classification / notation. For instance, ${}_{M}M(XY)_{F}$ would be a typical male and ${}_{F}F(XX)_{M}$ would represent a typical female. On the one hand, the brackets $(\cdot)$ indicate that the genomic configuration is not directly observable. On the other hand, the genetic setup (e.g., XY) is written in capital letters, since the former is easier to access than the attributes in the subscripts, i.e. gender identity and orientation.

Of course, there are more genetic types than just XX and XY. As is to be expected, XXX typically codes for a woman with above-normal female attributes (known as 'super females' or Triple X syndrome). XXY leads to low levels of testosterone and the Klinefelter syndrome, i.e., men who tend to be asexual or possess a number of female features. Finally, XYY produces high levels of testosterone, leading to what are known as 'super males', i.e., men with distinctively male features. In our notation these verbal descriptions become:

$${}_{F}F(XXX)_{M} \qquad {}_{M}M(XXY) \qquad {}_{M}M(XY\,Y)_{F}$$

Directly observable social gender could also be included, for instance ${}^{F}{}_{M}M_{M}$, representing men who like to display female behaviour, for instance the fa'afafine in Samoa and the muxe gunaa in Mexico ([26], pp. 83-84). The superscript F indicates that the property of gender expression is very easily observable.

Allowing for intermediate phenotypes, one could extend the binary classifications to a trinary system. In a addition to F and M one had the intermediate category 'B' between the 'poles' of male and female, i.e.,

Sex (body characteristics):	Gender identity:	Orientation: bisexual	
hermaphrodite	androgynous	(private)	(public)
${}_{?}\mathrm{B}_{?}$	${}_{\mathrm{B}}{}^{?}{}_{?}$	${}_{?}{}^{?}{}_{\mathrm{B}}$	${}_{?}{}^{?}{}^{\mathrm{B}}$

In a nutshell, there is no such thing as a single middlesex [27]. Rather, in every dimension considered, there is at least a third form of sexuality that has to be taken into account: a mixture of male and female properties with respect to body, mind, orientation, and expression. Overall, there are then $3^4 = 81$ different categories, and several times this number if gonosomes (XX, XY, XXY, . . .) are also considered.

The next step would be to differentiate between various manifestations of gender identity or sexual orientation, for example along the scale F − [Fm] − [FM] − [Mf] − M, with the lower-case letters indicating a less dominant but nevertheless existing trait or interest in that direction.

Moreover, it is possible to include further characteristics. Orientation, for instance, may be virtually non-existent (asexual A), arbitrary / pansexual (*?*), pedophile (C), or toward some fetish.

A few Interesting Cases are:

${}_{M}B_{F}$	straight man with a hermaphrodite body
${}_{B}M_{M}$	androgynous and gay man
${}_{F}F_{B}$	bisexual woman
${}_{B}F_{B}$	biological female
${}_{M}B_{B}$	psychological male
${}_{M}M_{?}$	pansexual male
${}_{M}M_{C}$	pedophile man
${}_{A}A_{A}$	neuter in every dimension

Summary: A Realistic Model and Explanation

A realistic causal model could start with the genetic setup and should emphasize crucial underlying mechanisms such as the sex-determining region on the Y chromosome that triggers the production of testosterone. Some effects are well-known, for instance, as is to be expected, CAH (congenital adrenal hyperplasia) leads to a masculinization of female offspring - with respect to the body (e.g., a larger clitoris); general behaviour, with individuals being rather interested in organisation and 'things' (than interactions with persons); and sexual orientation (i.e., the percentage of F_F's is elevated) [16]. However, testosterone is just the most prominent androgen, i.e., there are further hormones working in the male or the female direction, such as estrogens.

Although the production of hormones is basic, their effect on tissues is modulated by further factors, receptor sensitivity in particular. Consistently, men with AIS (androgen insensitivity syndrome) develop in a direction that is typical for females. Somebody with complete AIS may become a woman and compete as a female athlete. The fraternal birth order effect is also well-documented, i.e., homosexual men have, on average, a larger number of elder brothers than heterosexual men. This could be due to a maternal immune response, blocking the usual effects of testosterone and its ilk, which, in particular, makes the

outcome M_M more likely.

The idea that three critical phases subsequently determine sex, gender identity and sexual orientation seems to be the simplest hypothesis perceivable. If so, one would be interested in their onset, duration, and potential dependencies. If this idea was basically correct, it had the remarkable consequence that 'intervention windows' were small and that any kind of conversion therapy later in life were futile. (It may be noted in passing that this would be just the opposite if a person's gender identity or orientation were 'fluid', i.e., not fixed but variable. Since all kinds of conversion therapy have failed, this provides strong evidence in favour of stable identities and orientations.)

Applying Occam's razor once again, a single latent factor - testosterone - could trigger the development. Thus, we arrive at the following model, extending Table 2:

Route	Genetic Setup (Sex Chromosomes)	Hormonal Regime	1. Body	2. Mind	3. Orientation	Result
A	XY	Testostrone: high	M	M	F	${}_M\mathrm{M}_F$
B	XX	Testostrone: low	F	F	M	${}_F\mathrm{F}_M$

In other words, in most cases sexual development either follows route A or route B: the genetic setup triggers the amount of testosterone, which has lasting effects on the body and the psyche, such that the result is either a 'regular guy' or an 'ordinary girl'. Moreover, the list of outcomes in Table 1 would be mainly due to transitions between routes A and B during the sensitive time periods 1.-3.

However, since reality is always more complex than one figures, augmenting this basic explanatory structure with important details seems to give the most parsimonious and realistic theory of sexual development. For instance, and in addition to the variations already discussed, so-called guevedoces have testes and "a female external appearance" at birth [26], p. 85. Thus they are raised as girls (${}^F B(XY)$ in our notation). With the onset of puberty, larger testosterone levels make the clitoris grow into a penis, so that they become $M(XY)$. Nevertheless, some seem to be ${}_F M(XY)$, since they transition to ${}_F F(XY)$. The pronounced recent increase of rapid-onset gender dysphoria (ROGD) in adolescents – mainly females – also points to social factors that may influence sexual development, at least with respect to the public expression of gender [28, 29].

Whatever the details, knowing the crucial factors that shape the outcome in the basic dimensions, would make it possible to focus therapeutic interventions on achievable targets [30]. Diagnostically speaking, if certain hormone levels and immunological parameters are decisive at particular moments in time, the corresponding variables cannot be altered afterwards. On the other hand, deliberately ignoring fact-based biology and neglecting rational scientific argument, myths that do more harm than good evolve [26]. In particular, treating issues of sex and gender without – or even against – the relevant scientific background is as error-prone as surgery ignoring anatomy.

Dedication

This paper is dedicated to the memory of my teacher, Dirk Hellhammer (1947-2018), Professor emeritus at Trier University, Germany.

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