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Incorporating Information from Neuroscience and Endocrinology Regarding Sexual Orientation Into Social Work Education

Abstract

The brains of heterosexual males and heterosexual females are different. Moreover, the brains of gay men are similar to heterosexual females whereas the brains of lesbians are similar to heterosexual males. Neuroscience research supporting these postulates is reviewed. The gestational processes that might explain the differences in brain structure and function corresponding with gender are reviewed. Following a discussion of the physiological bases for sexual orientation, a discussion of the physiological bases for the expression of gender related traits and a discussion of factors contributing to sexual identity are provided. Throughout the article, alternative ways to think about gender are suggested. The importance of integrating the information presented in this article into the curriculum of Social Work Education is explained.

Incorporating Information from

Neuroscience and Endocrinology

into Thinking about Gender and Sexual Orientation

In the 2003 presidential election, a very tight race, the issue of same sex marriage may have been the deciding factor in determining the outcome. Closer to the Social Work professional community, the issue of sexual orientation having biological origins versus a social learning origin was raised by David Hodge and Fredric Reamer in a Aletters to the editor@ exchange about the degree to which social workers should espouse the beliefs of the general population (2003). In considering these controversial topics, the question of the degree to which the profession should be informed by new information from the field of Endocrinology and Neuroscience arises. Our profession is committed to evidence-based practice, however, Social Work has yet to take a stand on other epistemological issues (e.g., the debate on evolution versus creationism). Do we as a profession, decide truth on the basis of scientific observation or are all beliefs given equal status? In line with the position that we should commit to science as a legitimate epistemology, some new developments emerging from Neuroscience pertinent to sexual differentiation will be presented. Throughout the discussion, perspectives about how best to think about gender are offered.

Is Sexual Orientation a Choice?

Answers from Neuroscience

In response to Shakespeare's question, "tell me where is fancy bred, or in the heart or in the head?" neuroscientists, Morris, Gobrogge, Jordan, and Breedlove (2003) respond that love

and desire are generated in the brain, the organ that generates all thoughts and feelings. To find an explanation for the origin of sexual orientation, the brain is the most likely place to look. In developing their explanation of sexual orientation, Morris et al. advance two key postulates: (1) the brains of male and female heterosexuals are different; (2) the brains and nervous systems of gay men are more similar in structure to the brains of female heterosexuals while the brains of lesbians are more similar to male heterosexuals. Empirical findings support each postulate.

Structural Differences in the Brains and Nervous Systems of Heterosexual Males and Females

Many structural differences are found between the brains of adult heterosexual men and heterosexual women. The size differential between the left and right hemispheres is greater in men than in women. Further, structures connecting the right and left sides of the brain (viz., the corpus callosum, the anterior commissure and the massa intermedia of the thalamus) are denser in women. Possibly as a result of the greater connectivity, women are much less likely to lose particular abilities as a result of a stroke involving one side of the brain. Moreover, women tend to use both sides of their brain for tasks which only activate one side of the brain in men (Nelson, 2005).

While general differences exist between male and female brains, for the question of sexual arousal, the hypothalamus, the structure that organizes sexual responding as well as driving production of gamates (sperm and egg), is particularly relevant. Differences between the hypothalami of men and women would, of course be predicted on the differential reproductive tasks of the two genders. Men and women differ considerably in how glandular reproductive functions are performed. Males continuously produce sperm. Females release an ovum each

month. Since the hypothalamus, through secretion of Gonadotropin Releasing Hormone directs the production of sperm and egg, one would expect structural and connectivity differences in this brain areas which correspond with their distinctive timing patterns for hormonal release (Gilbert, 2005, p. 559; Nelson, 2005).

Consistent with expectation, the hypothalamus differs structurally between the genders. Several nuclei in the medial preoptic area are larger in males. The Bed Nucleus of the Stria Terminalis is larger in males. Women have larger suprachiasmatic nuclei, the clock structure in the hypothalamus, possibly adapted for the task of timing the activity of the ovum release (Nelson, 2005).

Beyond directing the production of the sperm or the egg, the hypothalamus also organizes the proper autonomic response for sexual performance. In males the medial preoptic area of the hypothalamus is particularly important in directing copulation. The sequence of sexual responding occurs as follows: A male rat gets exposed to a female animal who emits an estrogen-type-pheromone. (Pheromones are chemical communication signals between members of the same species which drive hormonal function). The estrogen-pheromone excites neurons in the nasal passage. The message gets sent to the accessory olfactory bulb that projects to the medial amygdala which then projects to the Bed Nucleus of the Stria Terminalis which finally projects to the Medial Preoptic Area of the hypothalamus. The Medial Preoptic Area arranges for the release of testosterone, projects to other areas in the hypothalamus to establish the proper function in the autonomic nervous system to support copulation, as well as projecting to the midbrain to release the motor program for mounting.

Of course, if a male rat detects a male hormone, mounting behavior would not be

anticipated. Indeed, if an androgen-type-pheromone is released from the conspecific (same species animal), then different circuits (neural connections) from the nose through the hypothalamus will result in exhibition of aggression rather than mounting behavior by the male rat (Baum, 2002; Carlson, 2003; Nelson, 2005).

In female rodents, the ventromedial hypothalamus is more important for organizing copulation rather than the medial preoptic area. In females, the input from receptors for androgen-pheromones in the nasal mucosa will terminate in the ventromedial hypothalamus (Nelson, 2005).

The wiring in the hypothalamus underpinning sexual responding in male and female rodents differs considerably. Because it is possible to place detectors for neuronal activity into the brain of a moving animal, it has been possible to map out neuronal connections in rats. Similar studies have not been performed on human beings for obvious reasons. But, brain imaging studies of human brains responding to pheromones have been conducted. Findings are consistent with the view that human female and male hypothalami also exhibit different circuits for responding to a given pheromone.

Functional differences between the human hypothalami of men and women. Heterosexual human females respond to androgen-pheromones with activation in the preoptic area and the ventromedial nuclei. These same areas are activated in heterosexual males by a female pheromone. How do heterosexual brains respond to pheromones emitted by the same gender? Androgen-type-pheromones activates the general odor areas in heterosexual males; estrogen-type-pheromones activate the general odor areas in heterosexual females (Savic, Berglund, & Lindström, 2005).

Functional differences in auditory function of men and women. Click-evoked otoacoustic emissions constitute another indicator of functional differences in the nervous systems of heterosexual males and females. Women are more sensitive to hearing tones than are men (Nelson, 2005). An explanation for this enhanced auditory acuity has not been advanced. However, there are some additional ways in which the ears of women differ from those of men. Otoacoustic emissions are echolike noises generated by the cochlea of the inner ear. Otoacoustic emissions can be measured by inserting very small microphones into the outer ear, sending a series of clicks into the ear, and then detecting the echos with the microphones. Heterosexual women exhibit louder otoacoustic emissions than do heterosexual men (McFadden & Pasanen, 1998).

Summary. The nervous systems of the male and female members of rodent and human species exhibit considerable structural and functional differences. This should not be surprising given the obvious differences in the way reproductive functions are conducted in the two genders. Not surprisingly, major structural and functional differences are found in the circuitry and the function of the brain structure which organizes sexual responding and gamate production: the hypothalamus. The next question is to consider whether gay and lesbian brains are more similar to the brains of others in their assigned gender or more like the brains of those of the opposite gender.

The Brains of Gay and Lesbians Differ in Structure and Function from their Heterosexual Counterparts

The brains of gay males are more similar structurally to the brains of female heterosexuals. The INAH3 nuclei in the medial preoptic area of the hypothalamus are smaller in

gay males and heterosexual females than they are in heterosexual males (LeVey, 1991). The suprachiasmatic nuclei of gay males are enlarged as they are in female heterosexuals (Swaab & Hofman, 1990). The size of the anterior commissure (connecting input from the nose) is 18% larger in gay males than in heterosexual females and 34% larger than in heterosexual males (Allen & Gorski, 1992).

In terms of brain function, the brains of gay men on particular measures exhibit the female pattern. When Savic, Berglund, and Lindström (2005) exposed gay males to AND, they found that the preoptic area and the ventromedial hypothalamus were activated. That is, the gay males displayed the female response pattern. (Savic et al. did not examine the responses of homosexual females.) On the otoacoustic emissions measure, gay males did not differ from heterosexual males. However, lesbians differed from both males and heterosexual females, being midway between them (McFadden & Pasanen, 1998).

Evidence suggests that in responding to pheromones the brains of gay males are more feminine in pattern. The brains of lesbians exhibit a more masculine pattern than female heterosexuals. It should be noted that there are ways in which gays and lesbians do not differ from their heterosexuals in their assigned genders. The levels of testosterone and estrogen do not seem to vary between gays and lesbians and heterosexuals, although they do vary as a function of whether one has testes or ovaries (Nelson, 2005).

The next section of this paper, we will consider how the differences in brain structure and function might be brought about either during fetal development or after birth. But, before changing focus, it should be noted that once the pattern of responding in the hypothalamus to various hormones has been established, it is set. No one has ever been able to alter the circuitry

once established.

What Processes Account for the Structural And Functional Differences in Male versus Female Brain

The data are clear that the brains, both structurally and functionally, do differ from their heterosexual counterparts. But, what can explain these differences, was it nature or nurture which altered the structures? The scientific community is also not decided about which factors cause sexual orientation in heterosexuals or in gays and lesbians (Morris, Gobrogge, Jordan, & Breedlove, 2004). On the side of nurture, neuroscientists appreciate that the brain is a plastic organ. New neuronal connections can be established in response to experience. For example, the hippocampi of London cab drivers are larger than the general population. (The hippocampus is involved in the formation of new memories, particularly memories about locations in space.) Moreover, cab drivers= hippocampi enlarge over the course of their learning the job (Maguire et al., 2000). In finding the smaller INAH3 nucleus in the medial preoptic area of the hypothalamus, LeVay (1991) raised the possibility that the structural difference may have resulted through differential exposure to particular experiences occurring after in utero development. However, with regard to the more masculine functioning of lesbians on the click-evoked otoacoustic emissions, McFadden and Pasanen (1998) reflected that this measure is stable across the life-span, so it is doubtful that results from life experiences after gestation (McFadden & Pasanen, 1998). In the next section, the case for the feminine brains of gay men and the masculine brains of lesbians resulting from differential exposure to particular hormones during fetal development will be explored.

The Case for Nature Being the More Important Factor in Influencing Sexual Orientation

While most neuroscientists demure from claiming that physiological processes determine sexual orientation, there are strong reasons to suspicion that sexual orientation is determined in utero. These suspicions rest on several bases: knowledge of the hormonal processes involved in genderizing the fetus; observations of the gender orientation in those with medical conditions in which the processes of genderization fail to follow a consistent pattern across organ systems; observation in other species involving manipulation of genderization processes in utero, observed association of traits known to be influenced by hormones available during gestation with gender-orientation, and findings from genetics and familial association studies.

How does the fetus become gender differentiated? Biologists refer to structures that differ between the two genders as dimorphic structures. These structures include the gonads, the external genitalia, and the brain. The process of gender differentiation of the cells in the fetus begins at about the week 7 after conception with differentiation of what biologists call the indifferent gonad. Basically the default value is for fetus, the brain, the external genitalia, and the gonads to become female. The process of masculine development requires hormonal intervention. Of course, those destined toward male development carry an X chromosome and a Y chromosome, whereas those destined toward female development carry two X chromosomes. Actually, unlike other chromosomes, the Y chromosome is pretty small and does not code for many proteins. However, the SRY protein (coded by the sex determining region DNA of the short arm of the Y chromosome) induces the core of the indifferent gonad to proliferate at the expense of the outer layer (which would otherwise develop into ovaries) and develop into testes. Once present, the testes are induced to secrete testosterone and Müllerian Inhibitory Factor by a hormone from the placenta (Gilbert, 2005; Rosensweig, Breedlove, & Watson, 2005).

The next step is the development of a ductal system which will connect the gonad (ovary or testes) to other structures. Initially, the fetus harbors both a rudimentary Wolffian ductal system and a rudimentary Müllerian ductal system. If the testes are secreting testosterone and Müllerian Inhibitory Factor, the testosterone will direct the development of the Wolffian ductal system to become the epididymus, vans deferens, and seminal vesicles. The Müllerian Inhibitory Factor will cause the Müllerian ductal system, which would otherwise develop into fallopian tubes, uterus, cervix, and inner vagina, to regress (Gilbert, 2005, p. 549).

Next comes the development of external genitalia. The skin tissue around the urethra must be induced to form a scrotum and penis, rather than to remain as the labia and clitoris. But here, testosterone from the testes will not do the job. Rather, the testosterone must be converted by an enzyme (5-α-reductase) to a stronger form of testosterone (dihydrotestosterone). Dihydrotestosterone will induce cells to become the scrotum and penis.

Masculinizing the brain is a complex process. (Remember, without exposure to hormones, the brain will be feminine.) While testosterone from the testes is the stimulus for the process, much of the testosterone is aromatized to estrogen by enzymes in brain tissue. Masculinization of the brain is brought about by estrogen operating through several different types of estrogen receptors. Additionally, some of the masculinizing process occurs through androgen receptors as well (Breedlove & Hampson, 2002; Morris et al., 2004; Nelson, 2005).

Another trick must be accomplished in XX chromosome bearing, rodent fetus to avoid masculinizing the brain. The mother=s blood contains high levels of estrogen that can easily pass through the placental barrier and into the developing brain. The mother's estrogen could potentially masculinize the brain. But the estrogen from the mother is bound by alpha-

fetoprotein so that the brain avoids masculinization in the fetus (Gilbert, 2005; Nelson, 2005).

While the process of masculinizing the brain has been worked out to a large degree in rodents, because of the inability to experimentally manipulate human brains as researchers can the brains of rodents, definitive data are lacking. The extent to which the processes occur in the same manner in primates as in rodents is less clear. But for most biological phenomenon, consistency across closely related species in the molecular mechanisms undergirding the process is observed. Understanding how the brain is genderized in general, a reasonable assumption is that the same processes account for the masculinized brains of lesbians and the feminized brains of gay males.

Nature's experiments. Nature offers its own experiments in which the brain of an XX female is exposed to high levels of testosterone in utero. Individuals can lack the genes for one of the several of the enzymes (3-β-hydroxy-steroid dehydrogenase; 11-β-hydroxylase, 21-β-hydroxylase) required for the production of cortisol and aldosterone in the adrenal glands. The condition is called Acongenital adrenal hyperplasia@. Without a particular functional copy of a given enzyme, the adrenal glands convert the cholesterol into testosterone rather than converting cholesterol to cortisol and or aldosterone. In utero, the testosterone masculinizes the brain just as it does in an XY fetus. However, the adrenal glands do not produce enough testosterone to fully masculinize the external genitalia. The individual is born with ambiguous external genitalia. This condition is readily recognized because the lack of cortisol and aldosterone is life threatening. Without medical intervention, the infant will die (Nelson, 2005; Hadley, 2000). In addition to supplying hormones, often physicians intervene surgically to reduce the size of the external genitalia. Parents are advised to raise the infant as a girl.

Does the rearing process of these women override the biological masculinization of their brains? Despite being treated by the environment as girls, these children engage in higher levels of rough-and-tumble play, are characterized as Atomboy@, prefer male playmates and objects which can be projected through space (trucks, planes, balls) as toys (Berenbaum & Synder, 1995; Ehrhardt & Meyer-Bahlburg, 1981) and more often draw trucks and other vehicles in cold, dark colors (Iijima, Arisaka, Minamoto, & Arai, 2001). They engage in more lesbian fantasies than other women (Erhardt & Meyer-Bahlburg, 1981; Dittmann, Kappes, & Kappes, 1992). Thirty-seven percent of women with congenital adrenal hyperplasia self-identify as bi-sexual or lesbian (Money, Schwartz, & Lewis, 1984). However, generally the girls self-define as female (Ehrhardt & Meyer-Bahlburg, 198l; Migeon & Wisniewski et al., l998; Wisniewski, Migeon, Malouf & Gearhart, 2004).

Nature offers yet another example of the manipulation of testosterone levels available for masculinizing the brain. Blanchard (2001) has noted an association between having older male siblings and gay sexual orientation. The odds of being gay increased by 3.3 percent for each older male brother. Blanchard proffered a theory about androgens from first born males crossing into the mother=s blood. The mother responds to the foreign proteins by producing antibodies to the androgens from the earlier sons. In subsequent pregnancies with male fetuses, these anti-androgen anti-bodies cross the placental barrier and eliminate hormonal androgens that might otherwise masculinize the brain structures in a later born XY fetus. The nature of these antibodies has yet to be identified and the susceptibility of pregnant women to producing these antibodies has yet to be explored. However, some explanation is required to account for the increased prevalence of gay sexual orientation in males with older brothers. The explanation of

antibodies from the mother alterations in fetal testosterone levels seems plausible. Given alterations in androgens during pregnancy, gay-sexual-orientation results.

Experimental manipulations. Testosterone exposure during gestation has been ruled in as a factor in primates in the masculinizing of the brain by experimental work. Goy, Bercovitch, and McBrair (1988) injected pregnant monkeys with testosterone, which crosses placental barrier and should masculinize the brains of females. The female offspring of these mothers did mount their peers significantly more than monkeys who had not been exposed to testosterone in utero. Thus, testosterone exposure during gestation can result in male sexual responding is established in primates.

Given that establishing sexually dimorphisms in the brain during gestation is accomplished through hormones, the question of whether processes which have strong impact on hormonal output (viz., stress) might impact gestational outcome has been addressed. Pregnant rats have been exposed to bright lights, a strong stressor. The male offspring of these stressed mothers produced less androgen, had brains that were more feminine in particular structures, and displayed less aggression and rough-and-tumble play (Ward, 1992; Ward & Stehm, 1991). Human findings are consistent with animal data. Maternal stress occurring during the first trimester is associated with increased rates of gay-sexual-orientation male offspring. An increase in female bisexuality outcome is found among mothers who smoked during pregnancy and were stressed (Ellis & Cole-Harding, 2001).

Association of gender orientation with traits under the control of gestational hormonal exposure. There are traits that are known to be under the control of the hormones which bathed the fetus during critical periods of development. These traits include the previously discussed

click-evoked otoacoustic emissions, particular eye-blink reflexes, and the relative size of finger lengths. On all these measures, lesbians are more similar to heterosexual men (McFadden & Pasanen, 1988; Rahman, Kumari, & Wilson, 2003; Williams et al., 2000). Although the findings are less consistent for gay males being more similar to heterosexual females (McFadden & Shubel, 2002; Manning & Robinson, 2003; Rahman et al, 2003; Williams et al., 2000). Williams et al. (2000) suggest that there may be more than one developmental pathway to gay-sexual-orientation, with some pathways involving low levels of androgen exposure and others attributable to high levels of androgen exposure. As findings accumulate, a more fully articulated story is likely to emerge in the future.

Genetic Studies. Findings from twin studies support for inheritance of sexual orientation. For gay sexual orientation, Bailey and Pillard (1991) found a concordance rate of 52% for mono-zygotic twins, a concordance rate of 22% for di-zygotic twins, and a concordance rate of 11% for adoptive brothers. For lesbians, Baily, Pillard, Neale, and Agyei (1993) found a concordance rate of 48% for monozygotes, 16% for dizyogotes, and 6% for adoptive sisters. However, twin study methodology for estimating the relative importance of nature versus nurture in outcome can be questioned. One assumption of the twin methodology for estimating heritability is that the environment treats same sex-fraternal twins similarly to the same degree that the environment treats same sex-monozygotic twins. In fact, identical twins have much more contact with each other throughout life than do dizgotic twins (Littrell, 1991, p. 8). Further, contrasting concordance rates in monozygotes versus concordance rates in dizygotes will not merely reflect the degree of genetic similarity between the two types of twins. It is also known that while monozygotes share the same sequences of bases on their chromosomes, epigentic differences

between identical twins may be found. Epigenetics pertains to differences in how DNA is packaged. Enzymes pack up particular genes and make them inaccessible for producing proteins. Identical twins, because of differential exposure to chemicals in utero, may well differ to the degree to which their genes are epigenetically equivalent. Thus, assuming that any variance which cannot be accounted for by DNA must be ascribed to socialization, may be an invalid assumption.

Of course, with the sequencing of the human genome, the hunt is on for genes involved in accounting for variability among persons on all traits. Hu et al. (1995) and Hamer, Hu, Magnuson, Hu, & Pattatucci (1993) found an association between a marker on chromosome Xq28 and gay-sexual-orientation. However, Rice, Anderson, Risch, and Ebers (1999) were unable to replicate this finding. Moreover, Hu et al. remarked that the Xq28 marker was neither necessary nor sufficient to confer gay sexual orientation even within their selected sample.

Many genetic routes to changing the brain will probably be identified. Several types of receptors (alpha-estrogen, beta-estrogen, androgen) have been implicated in creating sexually dimorphism in the brain in rodents. For most processes, many signal transduction proteins are involved in transmitting the message from the receptor to influencing processes within the cell. The unfolding story on genetic factors in homosexuality is likely to be complicated.

Summary. Although neuroscientists cannot offer definitive proof that physiological processes occurring during gestation can account for all cases of same-sex-sexual-orientation, there is much circumstantial evidence to suggest that it is the case. The process of gender differentiation of the brain involves testosterone exposure during gestation. Nature's manipulation of this process in the case of congenital adrenal hyperplasia in females does result

in lesbian sexual orientation. The association between having more older male siblings and gay sexual orientation is probably the case of another of nature's manipulations of hormones bathing the fetus during gestation. Experimental manipulation of testosterone exposure in XX chromosome bearing primates results in male mating behavior. Lesbians exhibit traits known to be caused by testosterone exposure in utero supports the view that their brains were masculinized during gestation. Finally, genes associated with gay sexual orientation have been identified. Findings from many areas of research converge in suggesting that gestational processes account for gay and lesbian sexual orientation.

Differences in Interest Patterns Between the Genders and in Gays and Lesbians

If same sex-sexual orientation has its origin in genderization of the brain during fetal development, then it might be expected that gender-related interest patterns would differ in gay males as contrasted with heterosexual males and in lesbians as contrasted with heterosexual females. Indeed, gays display preferences for traditionally female occupations; lesbians display preferences for traditionally male occupations. On personality traits, gay men are exhibit more feminine traits and lesbians exhibit more masculine traits (Lippa, 2000; 2002). As children, gay men and lesbians often exhibit gender nonconformity in their behavior (Bailey & Zucker, 19950. Thus, the ramifications of having a feminine brain in gay males and a masculinized brain in lesbians is not limited to sexual orientation. Interest patterns and gender-related personality traits are consistent with the structural and functional pattern of their brains.

The animal literature suggests that hormonal exposure during gestation greatly influences the gender-stereotypic behavior of the animal. For example, female rats that are placed between

two male litter-mates in utero, and thus exposed to more testosterone, exhibit more male like levels of aggression (Nelson, 2005, p 156). Consistent with animal findings, human females who have twin brothers exhibit otoacoustic emissions more similar to males than females, although gender identity is female (Rosenzweig et al., 2005, p. 376; McFadden, 1993). Gestational hormonal exposure does influence the expression of gender-related traits.

Implications. The world has often gone through periods of great consternation when persons with male genitalia prefer sexual congress with men and are similarly disturbed when confronting a similar phenomenon in women. The brains of gays and lesbians do differ from the brains of heterosexual counterparts. The brain determines sexual responding rather than external genitalia. The brain also influences the expression of interest patterns and gender related traits. The brain may be the best indicator for making gender assignments along this masculine/feminine continuum. Using the brain to make gender assignments along a masculine/feminine continuum, might yield a different view of same sex marriage. Perhaps these unions are not same sex, after all.

Is Gender a Dichotomous Variable?

While research into the development of the brain is an emerging field and many questions are not yet answered, it is known that masculinization of the brain involves both estrogen and testosterone. Moreover, the estrogen acts at both alpha-estrogen receptors and beta-estrogen receptors. Particular components of behavior are entrained by development mediated through a specific type of receptor (Nelson, 2005). However, polymorphisms (different forms of the gene and thus the protein) exist in the human species for most proteins. Thus, individual brains might well vary in the extent to which each functions in a way that is consistently masculine or

feminine. The picture emerging from Biology is compatible with the work done in Social Sciences in the 1970 and l980s on the trait of androgeny. Many individuals exhibit both masculine and feminine traits (Bem, 1974).

As children we grow up believing that animals come in two forms: male and female. However, the more Biology courses one takes, the more this notion is challenged. Several fish species are hermaphrodites. Some of these fish species switch gender given a change in environmental conditions (sequential hermaphrodites). Others have both testes and ovaries and are called simultaneous hermaphrodites. The clownfish, of which Nemo is the most famous representative, are sequential hermaphrodites. Clownfish live in family groups of a mother, father, and offspring. If the mother disappears, the father morphs into the female gender. The oldest juvenile develops into a male and functions as the male mate (Nelson, 2005).

In Humans Gender Differentiation of Organ Systems Is Not Always Consistent

The masculinization of each organ system requires hormones, receptors that can respond to the hormone, and many proteins in the complex process of intracellular signaling to generate the end response at the cellular level (viz., cell proliferation or atrophy, making synaptic connections, etc.). Many variations on the process are possible. Sometimes people are born with both testes and ovaries, because the core of the indifferent gonad responds to the testosterone but the shell fails to atrophy. Sometimes XY individuals can not produce Müllerian Inhibitory Factor or they produce a receptor which fails to respond to the Müllerian Inhibitory Factor so they are born with both sets of ductal systems (Hadley, 2000). Then there are conditions where the external genitalia fail to correspond to the processes occurring in the brain.

In XY chromosome-possessing persons who lack a functional copy of the gene for 5-α-

reductase, the development of external genitalia fails to occur. Although these individuals have testes that produce testosterone; development of a penis, scrotum, and prostate requires the more powerful androgen, dihydrotestosterone. The 5-α-reductase enzyme is required to convert testosterone to dihydrotestosterone. Without the 5-α-reductase enzyme, the XY fetus is more female in external appearance. However, the brain has been masculinized because unconverted testosterone is available to bring about this process. Interestingly, at puberty, when the body starts producing high levels of testosterone, the surplus testosterone stimulates the growth of the penis. Suddenly, people who enter the world believing they are females, change gender identity. Consistent with brain development, most are male in their sexual orientation in adulthood (Gilbert, 2005, p. 558; Nelson, 2005).

In some families in the Dominican Republic, there is a higher prevalence of mutations in the 5-α-reductase gene. More individuals exhibit the phenomenon of being born with feminine external genitalia and then suddenly becoming masculine with an enlarged penis at puberty. In the Dominican Republic, such individuals are called AGuevedoces@ literally translated as Aeggs at 12" (Nelson, 2005).

Another way for a person possessing both X and Y chromosomes to be female in appearance occurs when the gene for the androgen receptor codes for a non-functional form of the protein. This condition is called Aandrogen-insensitivity syndrome.@ The individual has testes, because the SRY protein gets produced from the gene on the Y chromosome and induces development of the testes. The person produces testosterone which will be converted to estrogen for masculinizing the brain, (assuming brain masculinization occurs in the same manner in primates as in rodents). However, tissue destined for development into external genitalia and the

Wolffian ductal system cannot respond to testosterone. The individual is born with a female appearance, but lacks a uterus and fallopian tube and, instead, has testes in the abdomen (Gilbert, 2005, p. 557-560).

A lack of matching can occur between the brain and external genitalia in an XX possessing person as well. As has previously been discussed, individuals lacking in enzymes needed to produce cortisol shift from the production of cortisol to production of testosterone. Thus, the developing brain is exposed to masculinizing influence. The sexual orientation of these women is more often lesbian and they exhibit more masculine interest patterns and traits.

Summary

The foregoing discussion suggests that there are many people who will exhibit a mosaic pattern of gender traits. Moreover, in the animal kingdom, gender is not as fixed as some might think. Perhaps the way to think about gender is as a continuum rather than a dichotomy. There are many examples of androgeny.

What Causes Gender Identity?

The Science Jury is still out in terms of whether nature or nurture is a more important influence in how a human being will define himself/herself on the gender dimension. John Money, from Johns Hopkins, was very influential during the 1970s in advancing the position that gender identity is established by how the environment treated the child. The classic case was that of a boy whose penis had been inadvertently severed in the process of circumcision. Money met with the

the parents and urged them to raise the boy as a girl. Money=s group followed Joan through childhood and reported a successful gender reassignment. Diamond and Sigmundson (1997),

however, made contact with Joan later in life and learned that Joan, now John, had decided to live his life as a man and had married a woman. Subsequently, John/Joan committed suicide (Nelson, 2005, pp. 202-203).

The investigations of Joan/John raise the issue of how to best measure whether an individual is comfortable with his/her gender role assignment. For two legitimate groups of scientists to report such disparate findings about the same individual suggests a problem with inter-rater reliability assessing comfort level with gender assignment. Given the stigma attached to lack of comfort with gender assignment, studies relying upon self-report alone may not be an optimal way to assess comfort level with gender assignment.

The outcome of the Joan/John case suggests that brain genderization strongly impacts gender identity. The Joan/John case is consistent with recent findings following-up on XY persons with cloacal exstrophy. Individuals with cloacal extrophy possess testes. Their brains were probably masculinized. But, they were born without penises. (In some, the failure to develop a penis is attributable to androgen insensitivity.) In a study of persons with cloacal exstrophy, Reiner and Gearhart (2004) found that eight of the fourteen, who had been raised as girls by their parents, had declared themselves to be males.

Another opportunity to examine whether nature or nurture is more important in establishing gender identity is the study of XX individuals with congenital adrenal hyperplasia. Congenital hyperplasia girls have ovaries rather than testes. However, testosterone was produced by their adrenal glands during gestation and masculinized their brains. The standard treatment with these infants is to surgically remove the enlargement of the clitoris and scrotal tissue and raise these children as girls. Generally, women with congenital hyperplasia do regard themselves

as women consistent with how they have been raised (Ehrhardt & Meyer-Bahlburg, 1981).

There are inconsistent findings regarding how influential brain genderization is in determining gender identity. The relative importance of the factors that determine gender identity have yet to be determined. However, the significance of gender identity may vary among people. Certainly to transgender individuals gender constitutes a major self-defining attribute. For others, gender may not contribute as greatly to self-definition. In the Pulitzer winning novel, *Middlesex*, Jeffery Eugenides (2002) describes the life of a man with a mutation in the 5α-reductase gene. Having been raised as a girl, but in adolescence reassigning himself as a male, the character reflects upon his journey. He concludes that gender does not really matter that much. He realizes he related to his family members in the same way as a girl as he did as a man. They enjoyed the same jokes, talked about the same things, and maintained the same style in relating across time. Perhaps, like the main character in *Middlesex*, there are people who just do not rely on gender for self-definition.

Ethical Considerations

For those who are new to Biology, the potential to manipulate genes and hormones that influence fetal development usually seems formidable. In the near future, it will probably be possible to design a baby specifying gender orientation, gender identity, level of impulse control, level of math and spatial ability, and limitless other traits. In fact, the power to influence gender related outcomes has been present for many years. When an infant with adrenal hyperplasia, a mutation in the 5-alpha-reductase protein, or androgen insensitivity is born, most often the attending physician has advised parents regarding surgical intervention and whether to raise the child as a boy or a girl. The main character in *Middlesex*, an adolescent with a non-functional 5-

alpha-reductase protein, learns that his doctor is about to remove his phallus so he can continue to believe he is the girl that his parents raised. Learning of the impending surgery, the main character in *Middlesex* runs away. *Middlesex* offers a strong admonition that individuals should be consulted in decisions regarding their lives.

Physicians in the past have been in the drivers seat because of their monopoly on knowledge about physiological processes. Perhaps the time has come to broaden the diversity among decision makers rendering judgments regarding biological interventions. However, only through understanding the particulars can the ethical ramifications of each decision be fully appreciated. If social workers are to be involved in advocacy processes for clients and participants in decisions regarding medical ethics, understanding the details of the biological bases for gender orientation and gender identity will be a prerequisite. Hopefully, content on physiological processes undergirding gender differentiation will be included in Social Work education.

As social work educators, many of us are familiar with the struggle religious students experience integrating the perspectives on gay and lesbian issues presented in Social Work education and with what they have been taught to believe by their church leaders. Perhaps learning that sexual orientation is a biological given and does not involve a moral choice may help the students to accommodate to a fresh perspective.

Epilog

The purpose for this excursion into the world of Neuroscience and Endocrinology has been to bring pertinent findings on gender and sexual orientation to the attention of social workers. Ernulf, Innala, and Whitam (1989) have found that persons who believe that sexual

orientation is biologically based tend toward more tolerance for gays and lesbians. While the case for sexual orientation having its roots in genetic or hormonal factors as opposed to social experience has not been definitively decided, data support the conclusion that the brains of gays and lesbians are different, in important respects, from the brains of heterosexuals. There is, as yet, no evidence that these structures are mutable once established.

A second bottom line emerges from the study of Biology: Nature loves diversity. Perhaps as social workers, we ought to emulate nature in its appreciation of the benefits that can accrue when the species offers may different variations on how to be human.

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