Sex-based vision through the eyes of transsexuals undergoing hormone treatment

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May 12, 1999
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Abstract: Hormone treatment given to individuals to address transsexualism allows for a better understanding of how sex hormones affect people's cognitive processes. These hormones alter many elements of the brain, including the areas related to visual processing. With this in mind, it is quite possible that visual capabilities are sexed by the hormones in one's body. This paper presents currently known information about how hormones and vision interact, the reasons for its importance and directions that need to be followed in order to acquire more information.

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Introduction to the Topic

Vision is elemental to our way of life. Only when vision is impaired do we realize how essential vision is to understanding our world. From birth, we take this element of our being for granted without realizing how complicated the process is for our brains. One area of vision is particularly intriguing – how we understand a three dimensional world while the information stored by the retina is in two dimensions. The human brain uses a wide variety of tricks to develop this illusion in our brain. By understanding the tricks that our brains use, it is then possible to create visual illusions, such as the work done by Escher or the currently popular autostereograms (computer generated images that, when you look beyond them, produce a 3D image in your head). The best painters understand how we view things and exploit this to create realistic looking art.

Three-dimensional video games (PlayStation, Nintendo64) are another way in which we attempt to mimic 3D on a 2D plane. Unlike paintings, video games give the user the ability to maneuver through the artificial world, continuously bringing the current view (what the eye is expected to see if it was real) to the screen. These artificial worlds contain a lot less detail than the one in which we live, particularly in terms of color and shading. Men and women tend to perform differently[1] on video games and virtual reality (Cassell, 1999; Larson, 1999) and I am interested in understanding what might explain this. Various personal observations with my friends and their performance on various games only furthered my curiosity.

One possible explanation of why this occurs might be explored through an understanding of vision[2]. Sex hormones have been found in the retina and in sections of the brain which relate to vision (Lanthier, 1988). I propose that one explanation for these differences can be found through hormone related differences in people. Although we use various tricks to understand the vision in front of us, I believe that the magnitude in which we rely on one trick or another may be related to hormones. Thus our visual strengths and weaknesses are dependent on the hormones within our system. I am primarily interested in two types of techniques – 'flow navigation' and 'shape from shading'[3] and the relationship between them and sex hormones.

In order to determine whether or not hormones affect visual ability, a study is necessary. I propose that this study be first done with transsexuals, as they offer researchers a unique opportunity to see how recorded cross-sex hormone changes affect one person over time. Individual differences are important because all people range in their visual strengths; basing work on group averages would be useless. Regardless, it is important to realize that understanding the transsexual subgroup does not give an understanding of the whole population. Further

[1] An example of these differences might be necessary. Women tend to have more difficulties judging distances in 3D games, giving them a great potential to 'die' quickly.
[2] It is important to realize that this is not the only potential explanation. Other biological and social explanations are quite possible while a combination of explanations is more probable. Regardless, this is how my mind did go off in this direction because it is a potential explanation.
[3] Both flow navigation and shape from shading are explained in detail later in the paper.

research, beyond the scope of this proposal, would need to be done to see if what can be found in transsexuals can also be found in the general population.

I hypothesize that sex hormones are directly linked with differences in the vision processing of transsexuals. Particularly, I propose that testosterone encourages a preference for flow navigation while the lack of testosterone encourages a stronger focus on shape from shading.

Introduction to the Paper

Goal and Purpose

This paper is not the product of new scientific research. Rather, it consists of a compilation of information from various perspectives and disciplines to address one question – does vision change with the alteration of sex hormones? This paper attempts to make sense out of the work that has been done on vision in various fields (cognitive science, endocrinology, computer science, neuroscience and others) and combine it with what is known about and experienced by individuals who undergo hormone treatment to address transsexualism. Post-pubescent hormone treatment gives new insight into how sex hormones affect one's body. The primary goal of this paper is to gather the information that is currently known and understand what those within the field believe is possible. With that information, I then make a proposal about what needs to be done in order to question my hypothesis. Due to limited time and funding, it is not currently possible for me to complete the proposed experiment but I hope to complete that work at a later time.

In addition, I hope to make a large audience aware of the potential advantages in interdisciplinary work. For that reason, I attempt to give as much background to the various areas as I am capable of doing. One of the reasons that a wide audience is intended is because this work may lead to new interests in various fields. Also, I would like for any development in ideas to be accessible to all who it affects.

What will be Covered in the Paper

I intend to reach a wide audience with this paper. Primarily, my goal is to reach neuro / cognitive / biological / computational scientists as well as gender researchers. In addition, I hope to reach anyone who may have a related interest but does not necessarily have technical background. As a result, I have attempted to clearly describe much of the background that I use to formulate my hypothesis. For some of the readers, this information may appear too basic while for others, I did not use enough detail. I apologize to those who feel that this paper is on too high or too low of a level and I hope that it addresses the appropriate level for the majority of the readers.

I will first give some introductory information on how vision works in humans. Certainly, we don't know *how* vision works, nor do we know *how* the mind works, but I will share what is currently believed and understood. Particular attention will be paid to how three dimensional objects are converted into two dimensions by our retina and how our brains reconstruct that information to understand the three dimensional world. This information is intended for those who have minimal knowledge of how vision works or for those who desire a quick refresh.

Next, I will address the topic of transsexualism. An introduction to transsexualism and the current theories is given for those who are unfamiliar with them. I explain what is currently known about how sex hormones play a part in how people work. Following this, I explain how sex hormones are reversed in the transsexual by discussing what hormonal treatment is given and the possible consequences. Both feminizing and masculinizing hormones are covered.

After the background information, I discuss where vision and hormones overlap. One focus is what we currently know through various experiments, both on transsexuals as well as others. The information in this section of the paper comes from multiple perspectives. I include related research, anecdotal information citing what individuals have experienced or perceived, as well as what doctors and researchers currently know based on their experience with transsexuals and hormones. In addition, this section gives some background related to how I formulated my hypothesis. As this is not a currently researched topic, this is done through the eyes of what research has been done and the experiences that I have had with transsexuals and the Gender Team.

Finally, I will make a proposal for what work needs to be done in order to objectively understand whether or not sex hormones affect the vision of transsexuals. This includes my understanding of what is happening as well as potential experiments to be conducted.

My Point of View

I am not a doctor. I am not a transsexual. I am purely a student with an interest in how the body and mind works and how the results of those biological actions play a critical role in society. My background is simple – I question everything and do my best to make sense of it. I have a breadth of general knowledge but rely heavily on others for details. The work presented here is organized in a rather logical manner, a relatively scientific viewpoint. For this work, this mindset is most appropriate. Although much can be said about what individuals personally experience, I do not believe that they can recognize the subtle changes that are being addressed here with enough accuracy as is needed. This is also my bias – I am far more learned in the sciences than the humanities and, mentally, I rely heavily on the proof techniques offered by the scientific disciplines.

Aside from my scientific bias, I am certain that the identities that define me played a part in this work. I come from the United States, complete with American educational biases. I would be classified as female and white, two identities that I would prefer to escape. Although I do not identify as transsexual, I am friends with some who do and have become familiar with their individual ways of thinking, both about gender and other issues. In addition, I am familiar with transsexuality and transgender issues from a theoretical humanities-based perspective, as well as understanding the medicinal work.

When appropriate in this paper, I continue to offer where I stand on various disagreements. This is to inform the reader of my biases in doing this work.

From Then 'til Now: How I Chose This Topic

My curiosity began as a response to some work that I am doing regarding virtual reality (within the scope of computer science). Over time, I noticed differences in performance between individuals when dealing with a three dimensional video game where the goal required judging distance in the 3D world. These differences tended to fall along sex lines, regardless of how comfortable the individual was with the system. This observation was backed up by research (Larson, 1999). This struck me as peculiar and thus I started trying to understand why this sex-difference appeared. Based on the information that I have gathered, I believe that it may be due to a difference in sex hormone levels.

In current three dimensional computer systems, the image on the screen does not mimic the one that people would see in real life. The detail of shades, colors, and reflection used in reality requires too much computational time in our current computer systems, making it unfeasible. In addition, computer scientists doe not know how to make the graphics entirely realistic, but they are getting closer each year. The detail given by shades, colors, reflection, etc. is called 'rendering' and it is what makes one computer image look more realistic than another. In 3D games, speed is the most important factor, as current 3D games are primarily adventures or action games. Thus, detail is left out of the image. If a user relies on the limited detail for spatial information, the user is at a disadvantage.

I am intrigued by the possibility that the way in which our visual perception is highly dependent on the hormones that are circulating in our bodies. I am interested in understanding how biological and chemical factors predestine our strengths and weaknesses.

Current cognitive vision tests are being done haphazardly on the general population, both in North America and Europe. Unfortunately, these results are inconsistent and uninformative. For example, spatial relation tests were first done with the general population and then slowly subgroups were formed to understand the details. I do not believe that this method helps the understanding, but rather makes it a longer process. Personally, I think

that the population with the highest probability of results should be tested first. From there, one can develop more accurate tests for the general population.

In order to understand the possible relations between hormones and vision, it would be useful to work with populations who have controlled hormone intake that reverses the current hormone levels in the body. This would allow us to observe individual changes. Doing such an experiment on the general population is unethical and unrealistic. Only one subgroup offers researchers this possibility – transsexuals. This is because transsexuals chose to have their hormones altered and, thus, eliminate the ethical issue surrounding hormone treatment.

When I started this process, I naively assumed that I would be capable of running some experiments to get a rough idea of what is happening. Unfortunately, my bubble world collapsed and reality hit. Thus, my original ideas are more appropriate for Ph.D. work than for ISP work.

In addition to my scientific desires, I must admit that I am interested in working with transsexuals for a personal reason. Having friends who undergo this procedure makes me question the details of what alterations their mind is undergoing.

Why this Topic is Important

In addition to my personal reasons for doing this work, it is important to understand how this research could affect the public and future researchers.

Endocrinologists are constantly attempting to understand how the hormones that they prescribe are affecting the internal processes of the patients. In the case of transsexuals, it is rare that the individual notices the cognitive changes because s/he is focused on the physical effects. Although transsexuals are warned that hormone treatment may affect their mental capacities, since the endocrinologists are not exactly sure what could happen, they cannot offer more details. Some transsexuals do notice the cognitive effects and are either ecstatic or disappointed by them. For example, artists, poets, architects and computer specialists have reported noticeable cognitive changes that affect their ability to do their job. For some, this makes them regret their decision to start hormone treatment (Slabberkoorn, 1999b; Van Goozen, 1999). Having a full understanding of what changes one will experience post hormone treatment better prepares endocrinologists to treat transsexuals and other patients who have to undergo sex hormone treatment to address serious illnesses, such as prostate cancer.

Additionally, this research attempts to understand another slice of how the brain works. Neuroscientists and cognitive scientists are constantly attempting to solve our greatest mystery, how the mind works. This research continues those attempts and pushes it further. Understanding how the sex hormones within our body affect our

vision gives us a better understanding of both vision and hormones, currently unsolved mysteries. Certainly, this work does not solve or prove any great mysteries, but it opens up questions that may do just that.

Computers are infiltrating our world, much to some people's dismay. Certainly, computers are biased because their creator has biases that s/he unintentionally inputs into the computer. For example, if the primary programmer is male and the tester is male, there is a potential that the program does not address the needs of females. This could be the case with regard to vision and 3D representations on computer monitors. If computers are unintentionally biased in their performance, the social impact could be severe. When 3D graphical computers become essential for daily routines, it is important that all people have equal mental access to them. Since virtual reality and other 3D systems are only in prototype phase, this is an ideal time to learn as much as possible about how these systems could be biased and correct the problems before the technology becomes common and acceptable, which would force people to assimilate to a prejudiced technology.

Although finding differences based on sex has the potential to segregate based on that, my goal is to help find information so that researchers actions are less biased. For example, I would like to see more women on computers. If vision is one factor in that discrepancy, I would like to point this out to software engineers so that programs written become less sexist, giving women a greater opportunity for access. I believe that the understanding of this can be used by those whose creations are dependent on vision in order to eliminate sexist creations.

Finally, the more that one knows the better. Directed research often leads to questions and thus tangential research, more contemplative thoughts and issues that need to be addressed. Even by questioning this topic, I have impacted others thoughts about related topics as well as the potential impact of this one.

Defining Terms

For the purpose of this paper, I need to set up some basic definitions so I can use certain terms without confusion. When I refer to male/female or masculinizing/feminizing, I am referring to one's hormonal makeup. For the purpose of this paper, a male is defined as someone whose testosterone levels are close to the 225-900 ng/dL range that is common of those who relies primarily on testosterone. Males also have estrogen but that level is near 40 pg/mL. In this paper, female will refer to individuals whose hormones are primarily estrogen based. Their estrogen levels are probably between 40 and 800 pg/mL although it is possible that they are much higher. The big difference is that their testosterone levels are probably closer to a 25-95 ng/dL range (Israel, 1997, 70). Although these are rough levels, most people who have never received hormone treatment fit into one of these two categories. Most of the transsexuals that I have spoken with also fit into one of the two categories. Exceptions will be acknowledged. Based on one's secondary sex characteristics, a guess can be made about one's hormonal sex that is usually accurate, at least 99% of the time. When I refer to male/female, I

am not assuming anything about that person's genitals or preferred sex. Rather, these terms are only intended to create binary categories appropriate to this discussion.

Those who have started hormone replacement therapy (HRT) will be referred to as transsexuals, regardless of whether or not they have had sex reassignment surgery (SRS). Male-to-female (MtF) transsexuals will be referred to as 'she' while female-to-male (FtM) transsexuals will be referred to as 'he'.

In addition to these terms, which have common meanings, I have attempted to create a glossary of terms with which you may not be familiar. This can be found in the appendix. If you reach a word that confuses you, or a scientific word, the definition is probably in the glossary. I have also included footnotes to clarify concepts or terms that may be new.

Vision

Before I begin to explain some premises of vision, I need to advertise a wonderful book. Steven Pinker's *How the Mind Works* is intended to give the general reader, with no scientific background, a solid understanding of how the mind works. Within this book is a chapter entitled "The Mind's Eye" which gives a very concise and understandable description of how vision works, to the degree that is currently known. If you are interested in how the mind works, you *must* read this book.

Vision is *not* a solved problem. The information presented in this chapter is based on what is currently known or presumed about vision[4].

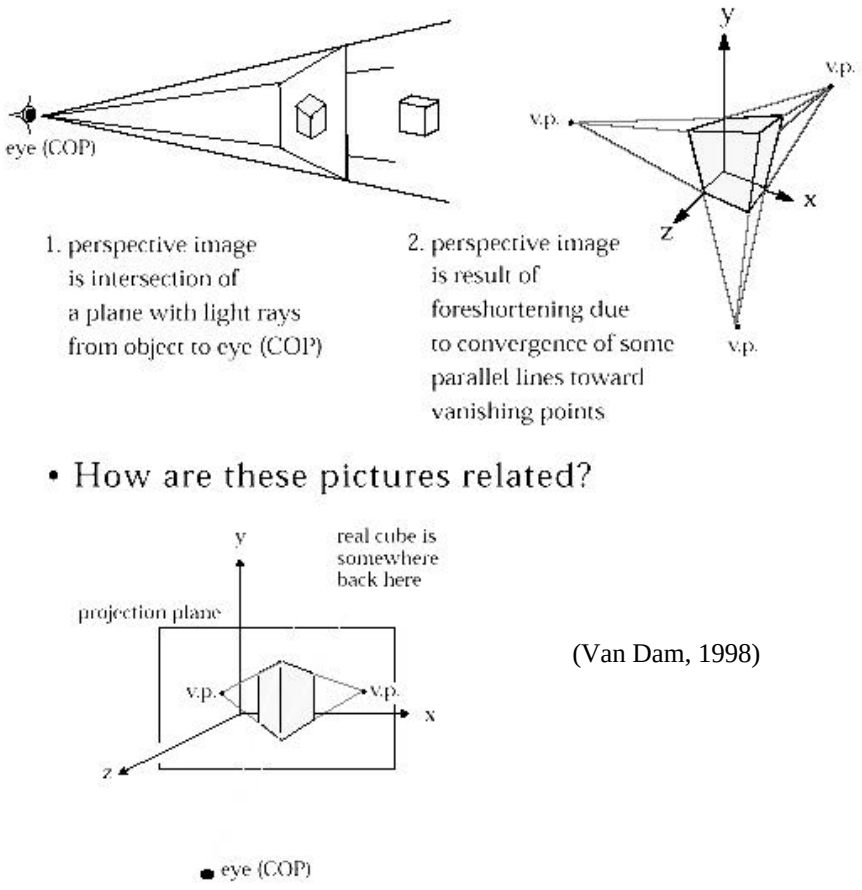
A Starting Point

> Vision begins when a photon (unit of light energy) is reflected off a surface and zips along a line through the pupil to stimulate one of the photoreceptors (rods and cones) lining the curved inner surface of the eyeball. The receptor passes a neural signal up to the brain, and the brain's first task is to figure out where in the world that photon came from. Unfortunately, the ray defining the photon's path extends out to infinity, and all the brain knows is that the originating patch lies somewhere along the ray. (Pinker, 1997, 215)

At any instant, our brains receive an image of the world in front of us, a mesh of colors in which the brain must translate. None of the information coming from our eyes tells the brain about all of the individual objects in front of us. Instead, our mind decodes all of the information sent to it, reengineers how the world must look based on the limited information that it receives. How this is done is a mystery that is currently unfolding.

[4] The information in this section comes from the cognitive science and computer vision fields. References used to develop this section include Van Dam (1998), Pinker (1997) and Cornsweet (1970). In addition, my personal background in computer graphics has helped me understand this information.

Take a look at the graphic on the right. Each eye looks outward onto a scene. The scene is projected onto a 2D plane, which is what our brain records. The information stored on the 2D image is not exactly what we are seeing. For example, we see a figure that we assume is a cube. In our view, we do not see right angles nor do we see square sides. Yet, based on our understanding of the world, we assume that we are viewing a cube from an angle.



(Van Dam, 1998)

Dimensions

Our ability to see in three dimensions is an example of how intricate our brain is. Although you may take three dimensions for granted, seeing 3D is not a simple task for our brains. Reflections of light are imprinted in two dimensions on our retina. This information is continuously passed to our brains to be decoded into a three-dimensional mental image of what is presented by the world. The initial assumption is that much is lost when the three dimensional world is crushed into two dimensions by our retina but here is where our optimized brain shows its brilliance. A combination of experience and basic assumptions allows the brain to reconstruct a three dimensional map of the world that is almost consistently accurate. Pinker explains that "the human visual system 'assumes' that matter is cohesive, surfaces are uniformly colored, and objects don't go out of their way to line up in confusing arrangements" (Pinker, 1997, 212). These assumptions allow the brain to accurately decode the compressed information passed from the eyes.

Assuming the aforementioned properties, how does our brain reconstruct the three-dimensional world in front of us?

One trick that we use is basic trigonometry. There is actually a purpose for having two eyes, beyond the ability to have a backup. Each eye has a slightly different view of the world. Test this by putting a finger in front of your face and then looking at it with one eye at a time; it moves in perspective. Well, our brain understood trigonometry long before we did. Put the finger back in front of your face. Now, focus on the finger. You will

notice that your eyes shifted, changing the angle in which they point. Since you brain knows the angle of your eyes and the distance between your eyes, it can easily determine the appropriate distance of that in-focus object. This is called stereo vision. Knowing that something in front of us is in focus returns to the basic assumptions about objects. Our brains are trained to constantly attempt to focus an object, through adjusting the angle in which the eye points and the magnitude in which the lens is open. When we are unable to focus that object, our mind gets very upset. That is what caused the headache the last time you saw an out-of-focus movie or sat too close to the screen[5].

Color and Shading

As you probably know, a color is shown because the pigment in the object absorbs a certain amount of the light and reflects another portion of it. Black absorbs the most light and white reflects the most light. Find a nearby object with consistent coloring (or imagine an apple). You know that the object has consistent coloring yet if a painter were to draw the object as s/he believes you perceive it, s/he will not use just one color.

What makes an object with consistent color appear to not have consistent color? The information that you receive about each point in the world's color is not just the color of the object of concern. Instead, the information is a combination of the object's color, shadows and the reflection of light and color from other sources (including lights and other objects' reflections).

Take a look at the picture on the right. Focus, for a moment, on the plate with the piece of toast on it. If you were asked if the center section of the plate was entirely white, you would probably say yes. Yet, because of shadows, obfuscation and reflection, there are a variety of colors displayed. In this image, you can see reflections and shadow. The glass of liquid shows how translucent materials also need to take into combination the color of what is behind the image. For example, the glass would look different if the tablecloth were green.

In addition, the various shading gives us varying information about the shape of the object. Refer back to the toast. Certainly, we assume that our toast has a (relatively) consistent color. Yet, because of the different

[5] One interesting tangent is what our brain does when it is unable to focus, or continues to see double. The brain knows that visual difficulties are often a sign that the brain has been poisoned, suffocated or bruised. For example, focusing is extremely difficult when you are drunk. As a natural reflex, in order to save itself, the body tries to eliminate those poisons, often through fast ejection of everything contained in the stomach. This is why some people get sick to their stomach when they are unable to focus after riding on an amusement park ride or experiencing virtual reality

shading (created by differing amounts of light reflecting), we can determine the texture of that object and thus have a better understanding of its shape.

In addition, color gives us an indication of where one object ends and where another starts. A sudden change in color is usually associated with an edge of an object or with a color change in the object (such as the ring on the plate). Recognizing shadows, shading and color gives us a better sense of where the object is located in space and its relationships with other objects.

Assumptions

We have briefly addressed a few assumptions that are made in order to understand objects, colors and positioning. It is important to truly understand what we are assuming and the possible implications.

"The world often contains parallel, symmetrical, regular, right-angled figures lying on flat ground, which only *appear* to taper in tandem; the tapering is written off as an effect of perspective" (Pinker, 1997, 217). That is why we perceive the cube as a cube, even though we cannot see the right angles.

"Objects have regular, compact silhouettes, so if Object A has a bite taken out that is filled by Object B, A is behind B; accidents don't happen in which a bulge in B fits flush into the bite in A" (Pinker, 1997, 217).

When we see a color, we assume that the color is due to the object because "earthly illumination is a rich mixture of wavelengths. The exception that proves the rule is the sodium vapor lamp, the energy-saving fixture found in parking lots. It sends out a narrow range of wavelengths which our perception system can't factor out; cars and faces are dyed a ghastly yellow" (Pinker, 1997, 247). In situations such as the parking lot, we know that the lighting is causing a change in color because we assume that one's face did not change colors recently. Thus, mentally, we did not have faith in the colors that we observe.

"Gradual changes in brightness and color across the visual field probably come from the way the scene is illuminated, whereas abrupt transitions probably come from the boundary where one object ends and another begins" (Pinker, 1997, 247). Certainly, this is not always true. Thus, we have to learn to distinguish between the edge of an object and between a sudden change in color. In this way, we combine the color information with the texture information. "Surfaces are evenly colored and textured (that is, covered with regular grain, weave, or pockmarking), so a gradual change in the markings on a surface is caused by lighting and perspective" (Pinker, 1997, 217). We combine the assumptions to understand the material at hand. Often, when the change in color is not accompanied by a change in texture, we assume that we are dealing with one object, not two.

Real world objects are made of wide variety of materials, each with different reflective properties. When determining the shape from the shading on the object, we take into account the potential material. We can do this because we assume that "surface lightness is uniform" (Pinker, 1997, 248). Thus, differences in surface lightness have to be caused by the material of the object. If we do not know the material, we learn about the material and store in our heads how light reflects off of it so that when we see another object with similar shading and reflection, we assume that the material is what we previously learned.

Although these are only a few of the assumptions our minds make when analyzing a scene, they are very intertwined to give us basic information about what we see. In this way, we can create basic rules in which we use to understand the information conveyed by our eyes.

Visual Techniques

By combining the assumptions that we use with the mechanics of our stereoscopic eyes, we can fairly accurately understand the world at hand. While our vision uses as much information as possible, it is important to realize the systematic way in which our brain works. When you have a group of assumptions and information, you must filter the image through each one at a time, slowly building up a basic idea of what is happening. In this way, our mind is procedural in its actions. We do this processing at a very rapid speed. A simple object can be understood relatively easily, probably using only one or two basic assumptions. A more complicated scene, especially one with various optical illusions or confusing matter, requires much more concentration and effort by our brains. So, if we look at the world procedurally, what techniques do we use and in what order?

I believe that the order of preference for various techniques is dependent on individuals. Certainly, if a person learns that one technique does not give any added information, s/he will stop using that technique to understand the scene. For example, once a person realizes that it is dark, s/he stops focusing on the shading of objects but rather focuses on other clues, such as relative movement of an object. I propose that the basic preference in techniques is dependent on sex hormones, which make certain techniques more useful.

Two specific techniques for visual understanding are recognized as being useful – flow navigation and shape from shading (Pinker, 1997, 220 & 249). These two techniques are primarily used to convey positioning of objects to the brain. Many of the assumptions discussed before allow you to understand how objects exist in relation to one another. In order to understand how they relate to you, you need more information. For example, a dot in your vision could be a small particle close to your eye or could be a huge sphere off in the distance.

One technique for determining this is 'flow navigation'. When you move towards the dot, it will get bigger. The magnitude in which its size increases in your vision is dependent on the size and location of the object. For

example, the small particle will get much larger much quicker in your vision than the distant sphere. The new position and size of an object within your visual field (and your body's innate understanding of how far you moved) tells you where that object exists in relationship to you and how its size compares to your own.

'Shape from shading' also allows you to ascertain properties of an object based on your relationship to it. Understanding how this works is a bit trickier. Take a look at a lit table in front of you. The light in the room reflects off of the table and your retina picks up the light that is reflected from each point that you are looking at, in the direction in which you are looking. The most reflection comes from the point on the table which is closest to where the light is directed, the angle in which the light is focused. If you move the light, you can see an impact on the shading of the table and the impact is directly related to how you move the light. In addition, the light casts shadows on the table, which are directly related to the positioning of objects in the way of the light as it heads to the table. Now, the angle between you and the table also plays a role in what you see. Although each point on the table reflects light in all directions, the most intense light will be reflected in a direction along the reflection angle[6]. If the angle between you and that point is along the reflection angle, you will see more light in the center of your eye than if you are looking at the point from a different vantage point. To see this, take a piece of cardboard and a flashlight. Aim the light at the cardboard and observe on point. Now, keeping the center of your eye focused on that one point, move your body so that you are looking at the cardboard from a very low angle. The shade of that one point changes slightly, since the reflection is minimized. As you change your vantage point or change the lighting scenarios, you can quickly alter the perceived shading of the object[7]. This allows you to get a solid understanding of where you are in relationship to the objects.

As you are already probably aware, each of the two methods has strengths and weaknesses. Shape from shading allows you to be less dependent on moving in order to understand the relationship while flow navigation allows you to be less dependent on surrounding light. A delicate balance of these two techniques is the most advantageous to the individual.

As I already mentioned, even if you balance these techniques, your vision will first use one and then another. I propose that testosterone focuses the minds brain along flow navigation, while the lack of testosterone brings the mind to use shape from shading at its primary technique. If this is true, it may help explain some observations found in the sexes (such as reported weaknesses in females when adapting to darkness or reported difficulties in differentiating between clothing shades in males).

[6] The reflection angle is the angle which is 180 degrees minus the angle in which the light hit, assuming a flat object. So, if the light comes into the table at 20 degrees, most light will be reflected out at 160 degrees, along the plane perpendicular to the surface.

[7] It is important to note that the center of your eye receives the most light and that your peripheral vision receives less. If you view one point from your peripheral vision, it will appear stronger through the center of your eye. The shading that I discuss is assuming that you are viewing the object/point from the same place in your eye at all times.

Transsexualism

Both theoretical information about vision and transsexualism are essential for understanding the suggested direction of this work. Thus, I am giving a brief background to transsexualism from two points of view. It is important to realize that transsexualism (or transsexuality) is a term used by both the medical community and the gender community. Although the differing groups primarily refer to the same people, the outlook and definition of transsexuality (both its causes and effects) is tremendously different.

Medical Viewpoint

> Transsexualism can be best defined as an extreme form of gender dysphoria. Gender dysphoria is a discrepancy between gender identity/role on the one hand and the physical characteristics of the body on the other. In transsexualism, the gender identity/role of the one sex coexists with the primary and secondary characteristics of the other sex in one and the same person. (Gooren, *Essays*)

Many people have attempted to define transsexualism in a manner that is understandable to both transsexuals and those who are completely unfamiliar with the feelings of gender dysphoria. Unfortunately, this is a difficult condition as there appears to be virtually no physical indicator that one is transsexual, only the consistent belief that this is the case.[8]

Transsexualism is still listed under the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (DSM) as a psychiatric disorder[9]. Criteria given by the DSM are usually used to determine the nature of one's illness and address ways in which physicians can help these individuals. According the DSM-IIIR, the criteria for being a transsexual includes the following:

1. Persistent discomfort and sense of inappropriateness about one's assigned sex.
2. Persistent preoccupation for at least two years with getting rid of one's primary and secondary sex characteristics and acquiring the sec characteristics of the other sex.
3. The person has reached puberty.

In the DSM-IV, an individual is given the psychiatric diagnosis of gender identity disorder if s/he has all of the following symptoms:

1. A strong and persistent cross-gender identification.
2. Persistent discomfort with his or her sex or sense of inappropriateness in the gender role of that sex.
3. Disturbance is not concurrent with intersex condition.

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[8] Zhou, Swaab et al recently observed a potential sex difference in the human brain related to transsexualism. One area of the brain, the bed nucleus of the stria terminalis, differs for men and women. This area is directly concerned with sexual behavior. In their study, they found that transsexuals have sizes comparable to those of the believed sex, not that of their biological sex. This research has presented a hypothesis whereby transsexuality results when hormones, released into the brain a few weeks or months after birth, match those typically released by the other sex. The result of this release is typing the sexual area of the brain in a manner that is opposite what the genitalia indicates. (Zhou, 1997)

[9] For both the DSM-III and the DSM-IIIR, transsexualism is given a separate category, 302.50. In the most recent edition of the DSM, DSM-IV, transsexualism is not labeled as a specific disorder but the same characteristics are categorized as generic Gender Identity Disorder, 302.xx.

4. The disturbance causes clinically significant distress or impairment in social, occupational or other important areas of functioning.

Although, transsexualism (and gender identity disorder) are considered to be psychiatric conditions, it is also considered to be "one of the most controversial and, in many ways, one of the more disappointing areas in psychiatry today" (*Treatments of Psychiatry Disorders*, 1989, 656). Attempts to treat transsexualism through psychiatry have failed repetitively, creating confusion amongst psychiatrists. While psychiatry has been unable to help these individuals, their situation is still considered to be a psychiatric disorder and in order to be eligible for sex change treatment, all transsexuals are required to go through massive amounts of psychiatric counseling.

Currently, the only known treatment for transsexualism is sex change procedures, either chemical or surgical or both. Attempts have been made in the past to treat transsexuals by flooding their system with the hormones of the sex of their body as well as through psychotherapy. No other method has worked (Hausman, 1995). Thus, gender teams are focusing on ways to improve sex change procedures.

The etiology of transsexualism and gender dysphoria is a primary concern to those interested in the field. In his thesis, Henk Asscheman addresses two medicinal theories that are proposed to explain transsexualism – somatic and psychopathological. Those who believe in the somatic approach believe that our lack of understanding regarding transsexualism is due to our lack of understanding of the effects of hormones on individuals as well as a lack of knowledge surrounding the biology and brain of the individual. The psychopathological theory can be broken into multiple schools of thought, all focused on how transsexualism is a means to address another problem in one's mind or misdevelopment (Asscheman, 1989). Most likely, agreement regarding this issue is not going to come soon.

Social Views of Transsexuality

In addition to the medical views on transsexualism, a great number of people are concerned with the social elements that 'cause' transsexualism. Feminists and queer theorists have frequently discussed transsexuality as a reaction to the social construction of gender in our society. A common thread in psychoanalysis is that transsexuality is believed to exist in reaction to society's feelings towards homosexuality. This may be due to a lack of understanding by psychoanalysts, who often see homosexuality and transsexuality as related because they are both forms of 'sexual deviance' (Doorn, 1997, 26). Even within the social viewers, there is a vast amount of disagreement.

Judith Butler claims that transsexuals are too focused on body parts in order to achieve sexual desires, implying that a transsexual desire only exists because of society's emphasis on the differences between 'penis' and 'vagina' and one's "imaginary participation" in these body parts (Butler, 1990, 70).

Some gender theorists believe that transsexualism cannot exist without the social construction of 'gender'. A discourse surrounding gender and sex is caused by the "presumption that underneath gender there is an irreducible, real biological sex" (de Castro, 1993, 18). If recognition of gender did not exist, there would be no concept of sex, only differences in bodies. The 'facts' (of biological sex differences) only exist as far as they have been described by acceptable discourses. "From this point of view, biological sex is not considered to be a static, prediscoursive entity. Thomas Laqeur, for instance, describes how, before the 19th century, the genitals of men and women were assumed to be essentially the same, be it that the former were situated outside and the latter inside the body" (de Castro, 1993, 19). Although this is no longer assumed by most people, it gives a great deal of insight into how sex was perceived.

The White Book offers a quick overview of Pat Califia's *Sex Changes: The Politics of Transgenderism*, a book written concerning the social and political issues surrounding transsexualism. The author quotes some of Califia's responses to medical views of transsexuality and I believe that they may give an added understanding of why there exists conflict between medical and social individuals.

> None of the gender scientists seem to realize that they, themselves, are responsible for creating a situation where transsexual people must describe a fixed set of symptoms and recite a history that has been edited in clearly prescribed ways in order to get a doctor's approval for what should be an inalienable right.
>
> [Money] is essentially a moralist masquerading as a scientist… It is bizarre and disorienting to read Money's self-congratulatory passages about these surgeries [on children with ambiguous genitalia], which most intact women with even a shred of feminist consciousness can only view as infant genital mutilation.
>
> Not a single recognized authority on this issue has said that transgendered people have intrinsic value and worth. (Califia, 1997)

While these statements (made by a non-transsexual) may not be representative of all transsexuals, they offer suggestions as to why there is tension between medical and social scientists. As was shown in the previous section, a great focus of medical issues concerning transsexualism relates to it being a disease (with a potential cure) and thus something that must be diagnosed carefully and monitored consistently. As individual's with a mental illness, transsexuals are frequently degraded and put into socially unacceptable positions. The social view on transsexualism is concerned with what social implications transsexualism has and how the individuals have been socially formed to see themselves as transsexuals. In addition, social scientists are concerned with eliminating the innate 'deviance' that is implied by the medical scientists.

The Middle Ground

Not surprisingly, there is little agreement between the medical and the constructionist viewpoints. When one 'proves' something, the other discredits it. Many social constructionists believe that there is still little natural difference between men and women, only socially constructed differences. Scientists usually look upon their history as complete with errors but regard current knowledge as dependable and provable.

My beliefs are a combination of the two. I believe that gender is socially constructed but I also believe that there are differences based on hormones and other biological factors and that society cements these differences. I believe in the possibility that sex differences exists and that sexuality and gender may also be written in the brain, although I don't think we are far enough along to know for certain. I support research to both credit and discredit existing theories, both in the humanities and within the sciences.

Finding a middle ground in which to communicate is difficult. While this paper primarily uses the medical standpoint on transsexuality, it is important to understand that disagreement with these theories are widespread. In addition, it is important to recognize that information contained in this paper may not be believed by all people, regardless of the reported credentials of the theorist cited. For that reason, I also suspect that some people do not want this topic to be discussed at all.

Sex Hormones

Sex hormones are usually divided into two categories – male and female. It is important to realize that both females and males have both estrogen and testosterone, only with vastly different levels. I will address these two categories separately.

Female Sex Hormones

The primary female sex hormone is estrogen. Estrogen is a type of steroid that is "primarily responsible for the conversion of girls into sexually mature women (development of breasts, further development of the uterus and vagina, broadening of the pelvis, growth of pubic and axillary hair, increase in adipose fat tissue)" (Kimball, 1998, SexHormones.html). In addition, estrogen is a primary tool for pregnancy, both the preparation of pregnancy through monthly menstruation as well as an actual pregnancy. In addition, estrogen is known to have two other primary effects – force the parathyroid to help prevent loss of calcium in bones and promote blood clotting. (Kimball, 1998, SexHormones.html)

Another important female hormone is progesterone, another steroid. Progesterone is primarily known for its effects on reproduction. Progesterone is the primary agent in making a womb hospitable for a child.

Often when women are older, their bodies stop producing estrogen and progesterone, resulting in menopause. This lack of hormones is often the cause for cardiovascular illnesses and osteoporosis, as well as other complications (Kirk, 1996, 16).

Male Sex Hormones

Testosterone, the focal hormone in a male's body, is the main steroid within the male. It is the secretion of testosterone that causes secondary sex characteristics in the male. For example, body and facial hair growth and deepening of the voice are all reactions to testosterone. Testosterone is also the primary cause for male-pattern baldness and for maintenance of the male skeletal system and muscular vigor (Kirk, 1996, 16).

It is important to realize that when people refer to androgens, they are referring to male sex hormones.

Importance of Hormones

Hormone	Female	Male	Units
Estrogen	40-800	<40	pg/mL
Testosterone	25-95	225-900	ng/dL

Above is a table of what is perceived to be a normal range of hormones. Note that biological women typically have estrogen ranges between 40 and 400 pg/mL while transsexual women (MtF) tend to have greater levels of estrogen, usually between 400 and 800 pg/mL (Israel, 1997, 70). Recognizing these levels allows the reader to realize that both hormones exist within an individual's body but that the levels vary based on sex. Individuals whose hormone levels range between these levels are often viewed as in-between. Such a chemical makeup produces characteristics of both sexes.

While the hormones are important at puberty to produce adult looking features as well as during pregnancy and pregnancy preparation in the woman, it is important to realize that hormones have a lifelong effect on an individual. Without hormone production, an individual is likely to develop one of many problems – from liver problems to cardiovascular problems to skeletal frailty. As a result, if a transsexual begins hormone treatment and gets beyond the point where s/he kills the hormone production in hir body, it is necessary for that individual to continue to take some form of hormone for life. Although two options have been presented here (estrogen and testosterone), there are also hormones that can be given that maintain the current level of hormones in the body (such as Livial).

Transsexual Hormone Treatment

The hormone treatment differs for males and females and, thus, will be addressed separately.

Female-to-Male Hormone Treatment

For FtMs, hormone treatment is quite simple – testosterone! Typically, FtMs use testosterone cypionate, an injectable testosterone that the patient injects once every two weeks. It is possible for FtMs to acquire testosterone pills or patches but this is rare, as the side effects are greater. The amount is controlled by the individual's endocrinologist but 200 mg is quite normal (Israel, 1997, 67). The result is quite remarkable. These individuals experience a second puberty. Facial, body and male-pattern pubic hair develops rapidly; muscle mass increases over time; the voice lowers to a typical male level; the skin thickens to a coarser level. Menstruation ceases, usually within three months and the body redistributes fat, which increases the waist size and decreases the fat pockets around the hips. The breasts do not reduce in size and height growth is not possible. A FtM can expect to gain around 10% in weight due to these changes (as well as increased hunger) (Israel, 1997; Whittle, 1998).

Testosterone is a much stronger steroid than estrogen and thus kills off much of the estrogen within the body. In addition, testosterone causes the body to stop producing estrogen, creating a chemical infirtilization.

In addition to the desired benefits, there are also potential side effects. These include (but are not limited to) "increased cholesterol and higher lipid levels; heart disease, including myocardial infarction; mood changes (irritability or depression); male-pattern baldness; acne" (Israel, 1997, 68). Although there is potential for problems associated with testosterone treatment, mortality rates among transsexuals are no different than amongst the general population (Van Kesteren, 1997).

Male-to-Female Hormone Treatment

MtF hormone treatment is much more complicated than FtM treatment. As was mentioned before, testosterone is a brutal steroid, destroying estrogen. Thus, when working with MtFs, it is necessary to first inhibit testosterone production prior to estrogen and progesterone intake. Usually, MtFs are treated with antiandrogens in order to do this. A typical regimen for a MtF includes antiandrogens (usually cypertone acetate), estrogen (often Premarin) and progesterone (often Provera). These are usually taking orally, twice daily. Unfortunately, the MtF hormone treatment does not offer ideal femininity. The treatment does not raise the voice if it is already damaged by testosterone nor does it reverse balding or hair growth in unwanted places such as the face. In addition, the penis size will not decrease with these hormones, although erections will become practically impossible and one's libido is diminished. Estrogen and progesterone do reposition the body fat into more

feminine places and is the cause of breast growth. Future body hair growth will be minimal and the skin can often soften.

Like any hormone treatment, there are potential side effects to MtF hormone treatments. Some of the complications associated with estrogen and progesterone are: thrombosis (blood clots in the legs, lungs, eyes, brain or other organs), breast cancer, liver disease, heart disease (including myocardial infarction), high blood pressure, sterility, mode changes, decreased sexual desire (Israel, 1997, 65). Side effects associated with antiandrogens are more controversial and will be discussed later in this paper. Even with these potential harms, mortality rate among transsexuals is similar to that of the entire population (Van Kesteren, 1997).

Views from Transsexuals

During my research, I spoke with a couple dozen individuals who have undergone hormone treatment to attempt to understand what they may or may not have noticed. I also spoke with other researchers who asked similar questions of transsexuals or talked with transsexuals about the changes they experienced. I would like to address these discussions at this point, as well as what I concluded from doing this activity.

Survey

In order to get a wide variety of transsexuals, I created a simple open-ended survey and put it online. I posted requests on various transsexual newsgroups and to various transsexual talk groups and to individuals who identify as transsexual. [The survey is included in the appendix.] The survey included a wider variety of questions than I needed answers to but I did not want to limit the questions to my goal so as to allow transsexuals to offer information, as they felt necessary. I desired to get anecdotal information to get a base understanding about how much individuals observed. The information gathered in this manner does not prove anything, but rather gives a rough sampling of what is observed.

A total of 53 male-to-females responded to my survey while only 9 female-to-males responded. More MtFs are treated each year than FtMs. This is certainly not the only reason why I received this type of response. I put my survey online and my requests there as well, which inherently limited the population who responds. All of my information and requests were in English, encouraging US, UK and Australian responses (although I did receive responses from others as well). Since I did not ask for location, only types of hormones given and optional email address, I am uncertain where most people reside. It is possible that the response is only indicative of those transsexuals online and not of transsexuals as a whole. In addition, I feel as though the MtFs were more communicative of their experiences, a trait that is also usually associated with hormones. This is also one of the reasons why surveys are not appropriate in this forum, as getting descriptions is highly dependent on people's experiences as well as willingness and ability to communicate those experiences.

In my survey, I asked about three primary visual changes – night vision, spatial relations and brightness of colors. For MtFs, I would expect a decrease in night vision, a decrease in spatial perception and an increase in brightness of colors. I expect the reverse from FtMs. Only three responses were not in agreement with what I should expect. One FtM remarked that he experienced a decrease in night vision. One MtF reported that "colors have become less constrasty." One FtM reported an increase in night vision.

Approximately 21% of the MtFs recognized a decrease in night vision abilities, particularly noticeable when driving. Only one MtF reported an increase in nighttime vision. One MtF noted that "colors are significantly brighter in the daylight, but less discernable at night."

The response to brightness of color was much more anecdotal. While 28% of the MtFs reported an increase in brightness of color, most said that the change is hard to describe. Some of these statements are:

- "With colors it is very subtle… If anything a very slight increase in color intensity."
- "More sensitive to light, color more vivid and 'sparkley'."
- "Colors are more bright then before, my eyes is more sensitive to red."
- "Perception of color is much stronger now, colors are much more brilliant"

In addition, approximately 32% of the MtFs reported a decrease in spatial relations and backed their remarks up with the following anecdotes:

- "Spatial relations? The best way to describe it is I experience objects more on an emotional level rather than just 3D objects."
- "I found after starting HRT that my spatial abilities suffered somewhat, or such was my *perception*. With time, I had considerable recovery of function, and I believe my spatial abilities are better now than before HRT."
- "For a time after each dosage increase I found myself feeling lost more often than usual, and I may have had trouble rotating objects mentally. There was one incident in particular where I could not figure out from an upside down mall map which way to go -- I had to walk around to the other side of the map, and yet this is something I do so automatically that I was startled by my inability."
- "My "internal compass" seems to be broken."
- "Spatial relationships between objects have been skewed, where I have had a harder time distinguishing their distances."
- "My sense of direction has gone from quite trustworthy to almost nil. In an underground parking lot I have absolutely no sense of direction at all...something I had before starting hormone therapy. It's hard to quantify such things but I would say my sense of direction prior to starting any therapy was 8 on a scale of 10. I would now place it around a 3."

The FtMs who responded to my survey shared very little information concerning the changes that they experienced related to cognition (most discussed sexual appetite change and feelings of being emotionally numb). One response, regarding spatial relations was:

- "Spatial relations were a problem when taking standardized tests in high school. After several years on hormones, when taking tests involving spatial relationship questions in college, I did considerably better."

In addition to the requested vision changes, a couple of people reported other changes that did not fit into the above categories. One MtF says she experienced an increase in difficulty in focusing her vision. Another MtF reports a newfound ability to see with her eyes closed. For another MtF, artificial light is now too bright to handle.

Most people do not recognize dramatic changes in their visual abilities. Those who recognize changes are frequently cued into to those changes because their jobs are dependent on it or because of a hobby or interest.

Conversations and Interviews

In addition to the survey, I engaged in one-on-one conversations with transsexuals and researchers. What I learned from these groups is similar to what I learned from my survey – some people notice changes but most people do not.

One interview did strike me as quite interesting as this FtM individual had multiple neurological disorders proceeding hormonal treatment, including prosopagnosia and various visuospatial difficulties. In addition, "Bob" has difficulty with bright lights and maintaining focus. Following testosterone treatment, "Bob" recognized two main things – an increase in his ability to be ambidextrous to a point where he is capable of using each hand equally as well and a newfound difficulty with letter order almost to a dyslexic degree. Because of his unique situation, he has had to develop skills to manage his vision. Thus, he is not certain what has changed due to hormones or other medications and what has changed as he has developed skills to manage his visual difficulties. Understanding how hormone treatment affects those who have already shown weaknesses in visual areas is another potential way of understanding how the hormones are affecting the vision.

In addition, during the work for her Ph.D., Stephanie Van Goozen recorded an anecdotal statement from a female-to-male transsexual who was acutely aware of his visual changes and the relationship between vision and language.

> I have problems expressing myself, I stumble over my words. Your use of language becomes less broad, more direct and concise. Your use of words changes, you become more concrete. I graduated with a 10 for Dutch. It is subconsciously different. It is a much more spatial, a more visual language. I can make comparisons more easily. I think less; I act faster, without thinking.
>
> I can't make fine hand movements any more; I let things fall out of my hands.
>
> The visual is so strong… when walking in the streets I absorb the things around me. I am an artist, but this is so strong. It gives a euphoric feeling. I do miss, however, the overall picture. Now I have to do one thing at a time; I used to be able to do different things simultaneously. (Van Goozen, 1994b, 10.6)

Such anecdotal remarks give evidence that the hormones are probably affecting vision and related cognitive processes. These effects are most acutely noticed by those whose lifestyle or job depends on it. One FtM individual who made her living through computer work expressed that she feels that hormones slowed her logic capabilities and hindered her spatial orientation on the computer.

Understanding the Personal Information

Anecdotal information does not validate my hypothesis but allows me to reshape it. Individuals' experiences must not be discounted as they provide direction and potential ideas. In addition, this survey allowed me to understand if my initial thoughts were flawed. In addition, it allowed me to understand that, while many people recognize some slight changes, the change is not dramatic nor do all people observe it and thus drastically affect their productivity. This means that only a well-gaged test will provide any reliable evidence.

In addition, one piece of information relating to control was raised through this subproject. It is essential to control for what hormone brand and type the test subjects are receiving so as not to get information that is a side effect of the hormone. Acquiring additional information such as this makes a survey valuable.

Bridging the Gap in Information

Knowledge about sex hormones and knowledge about vision are not two entirely separate areas. There has been some work done to bring these two areas of information together. Before doing further research, understanding what related work has been done is important.

Animal Research

Although transsexuals offer a great potential of information, it is not possible to manipulate the dosages or to use placebos for various reasons. It is unethical to do so considering that transsexuals go through an intense process to even be permitted to undergo treatment. In addition, since the physical effects are so dramatic, a transsexual would know quite soon that s/he had been given a placebo. Thus, much information can be gained through the use of animals[10].

Sex hormones are present throughout one's brain, including within the retina. The percentage and types of hormones present are sex dependent but the predominant primary sex hormones (progesterone, testosterone, estrone) have been found in both rats and post-mortem humans (Lanthier, 1988). Through various experiments with rats, we have learned that altering the hormone levels in the body affects the hormone levels in the retina

(Sharif, 1988). In addition, Lanthier observed that "when male rats are exposed to the scent and view of female rats, DHEA increased significantly in the retina" (Lanthier, 1988).

In goldfish, there is evidence that aromatase is present in a functionally defined neural pathway within the retina (Gelinas, 1993). Since aromatase converts testosterone into female hormones, this is an intriguing find.

While the significance of these observances is not clear at this point, these researchers hypothesize that the presence of sex hormones within the retina plays a role in the operation of vision and could possibly account for observed differences in visual performance between men and women.

Anandron Controversy

Anandron, a hormone given to male-to-female transsexuals, has caused a great deal of confusion related to vision ability. Anandron is an antiandrogen that has two main uses – to combat the androgens for MtF individuals and to treat prostate cancer. Unfortunately, this drug has a serious side effect – a rapid decrease in ability to adjust to darkness.

In *Transgender Care*, Israel states that "users of Anandron or Androcur (cyproterone acetate) may have visual difficulty adapting to darkness" (Israel, 1997, 58). Unfortunately, this information is partially inaccurate. Anandron is not a cyproterone acetate, but rather a type of flutamide. While there have been numerous reports regarding Anandron and visual difficulties, the same does not hold for Androcur. Cyproterone acetate is the most common antiandrogen given to transsexuals in the Netherlands because it is considered to be the safest (Asscheman, 1999). The latest research on cyproterone acetate has shown no evidence of visual concerns (Heinemann, 1997)[11]. Thus, I am just going to discuss what the remark regarding Anandron means in relation to what I am trying to understand.

In order to understand why this confusion exists, I would like to explain the importance of darkness as it relates to one's vision. In a darker environment, the range of potential shades is much smaller. For example, if a room is perfectly lit, you may see a white floor at pure white (say, 100% color). Now, imagine that a shadow can be seen on that floor (say, the shadow is 50% color). If the light in the room dimmed by half of its current coloring, the table would appear at 50% color and the shadow would appear at 25% color. By dimming the light, we have

[10] I am not saying that I personally believe that it is ethical to conduct these experiments on animals, but rather that it is common practice and considered to be more ethical than conducting similar experiments on people.

[11] Only one case of vision problems related to cypertone acetate (CPA) has ever been reported. In England, researchers observed that one individual experienced visual loss and optic atrophy as a result of taking CPA to combat prostate cancer. This individual experienced bilateral deteriorating vision and the first deterioration was to light/dark perception. The retina appeared normal and unchanged. When the individual stopped CPA therapy, the vision returned almost completely to normal within three months (Markus, 1992). The association was presented as probable but no follow-up study ever occurred. This observation was published in order to excite some research but the research never occurred.

also minimized the difference in brightness between the color of the table and that of the shadow, requiring more effort to tell the difference in shade between the two. Because darkness minimizes the range of possible shades in a room, it is more difficult for the brain to depend on shape-from-shading to get adequate information about information in the scene. In addition, a sudden bright light in a scene (for example, an oncoming automobile) startles the shape-from-shading element of vision detection into resorting back to full range detection. If the individual at hand is relying heavily on shape-from-shading, it is important that the range of shades do not change rapidly because this makes the process much more difficult.

With that in mind, a very important question rises in regard to what is noticed with Anandron – what is affecting the vision? Is the change due to a lack of androgen in the body or because it is being poisoned by Anandron?

Anandron is a type of flutamide, a nonsteroidal 'pure' antiandrogen. Theoretically, it is devoid of other hormonal activities. Potential complications due to flutamide include gynecomastia, breast tenderness and galactorrhea. All side effects are reversible (Dollery, 1999, F129-F132). In addition, there have been studies conducted to understand what Anandron does to one's vision. Approximately 65% of Anandron patients complain of visual difficulties. The most common is a delay in recovering vision after bright illumination[12]. This is due to an increase in photostress recovery time to an average of 9 minutes, while normal is 1 minute, 20 seconds (Harnois, 1986).

The noticed effect with Anandron seems to imply that the elimination of androgens in one's body causes the brain to focus heavily on shape-from-shading and thus be dramatically impacted by darkness. This effect is most probably due to an impact on the cones in the central fovea of the eye. Dark adaptation works because the cones in the center section of the eye adjust completely within 5 minutes while the rods in the outer section of the eye take about 30 minutes (Cornsweet, 1970, 139). When the cones are hindered, dark adaptation becomes more difficult. This has multiple impacts on the individual. First, it causes confusion within the brain when trying to register shades because the available light becomes too bright and it is difficult to distinguish between shades while the retina is still adjusting.

While the visual impact of Anandron does not give much insight into how antiandrogens impact vision, it allows for more questions to be raised. Primarily, what component in Anandron impacts the cones within the eye and is it possible that all antiandrogens do this but to a less noticeable degree?

Also, it is important to realize that much of what is known about Anandron is not available to the public but is kept confidential by the pharmaceutical companies (Asscheman, 1999).

[12] Quick changes in brightness can be due to naturally occurring phenomena, such as the sun, or by manmade objects, such as the television. Bright illumination refers to a sudden change in amount of brightness present in the current environment.

Drugs and Vision

Many types of drugs have been reported to affect vision on both temporary and permanent levels. This is important to consider, as the combination of drugs may be a primary contribution to observed changes. Vision complications are not just associated with prescription drugs but are also reported to be present in over-the-counter drugs, such as ibuprofen (Yee, 1990; Tullio, 1981). Various other drugs have been associated with vision atrophy and disturbances (Hollo, 1992; Couldwell, 1992; Mieczkowski, 1989). It is important to guarantee that any research done regarding hormone treatment and vision is not obfuscated by these other drugs.

Visuospatial Research

Visuospatial ability has received a considerable amount of scrutiny regarding the possibility of sex differences. Visuospatial ability refers to the mind's ability to make sense of spatial relations once the 2D map has been created inside the head. Mental rotation[13] tasks are common tests of one's visuospatial ability.

Sex differences in visuospatial ability have been pretty well established (Harris, 1978; Maccoby, 1974; Newcombe, 1982). Although there is a wide range within each group, the average male outperforms the average female on most visuospatial tests. At the very least, there is no significant difference in performance between the two groups. Prior to puberty, it is rare to find sex-based differences in visuospatial tests (Fairweather, 1976; Johnson, 1987). This is potentially related to hormonal changes, which occur at puberty and affect the visuospatial ability. While most people believe that visuospatial ability is related to sex, it is important to realize that others argue that the "95 percent of the variation is due to individual differences that have nothing to do with being male or female" (Fausto-Sterling, 1992, 33).

In order to understand what causes these repeatable differences, Van Goozen repeated these tests with transsexual subjects. Using the Ekstom's two-dimensional rotated figures test[14], she found that "higher testosterone levels resulted in females becoming better in visuospatial ability… whereas lower levels of androgens and higher levels of oestrogens had the effect of making males worse in visuospatial ability" (Van Goozen, 1995). While the results were in line with the expectation, Van Goozen expected to see a more dramatic difference in visuospatial ability, considering the dosage of the hormones that individuals are taking (Van Goozen, 1999). Van Goozen was unable to repeat previous research showing variations in visuospatial ability in women dependent on their menstrual cycle (Silverman, 1993).

[13] In a mental rotation test, the participant is often asked to determine which image is a rotation of the example image. This can be confusing because it is possible that the possibilities are mirror images of the object or otherwise not possible rotations. Usually, the amount of time required to figure out the answer is what is being tested.

Recently, Ditte Slabberkoorn followed Van Goozen's work over a longer period of time and with tasks that were not used in the previous study but were closely related. She replicated Van Goozen's finding that testosterone treatment had an enhancing effect on the visuospatial ability in female-to-male transsexuals while antiandrogen/estrogen treatment did not decrease the performance of male-to-females but they did not improve as much as they should have given the familiarity effect (Slabberkoorn, 1999a). In addition to using the same test that Van Goozen used (Ekstrom, 1976), Slabberkoorn used a three-dimensional rotated figures test[15]. She reported approximately the same significance on both tests.

Other research with non-transsexual men has shown that there is a direct relationship between testosterone levels and spatial ability (Hier, 1982; Christiansen, 1987). In addition, experiments were run using men with idiopathic hypogonadotropic hypogonadism (a disorder where puberty fails to occur and androgens are not released by the body). This research found that these individuals had impaired spatial ability in comparison to the control group; androgen therapy improved spatial ability in 13/19 subjects (Hier, 1982). This research suggests that sex hormones do play a definitive role in the sex differences found in visuospatial ability. While "androgens exert a permanent organizing influence on the brain before or at puberty in boys," it is uncertain as to whether or not induced hormone can alter the original 'permanent' effect (Hier, 1982). In addition, there is a potential link between seasons and visuospatial ability (Kimura, 1991) and between menstruation cycle and visuospatial ability (Silverman, 1993; Ho, 1986).

Although sex based differences were found in transsexuals, the expected amount of change in performance was not found. Thus, while hormones certainly play a role in affecting visuospatial ability, neonatal hormones probably still play a significant role in forming this area of the brain while later hormones may just activate these sex differences (Christiansen, 1987; Van Goozen, 1999).

The Gender Team chose to look at spatial relations and verbal fluency as its first two tests of cognitive changes. These tests are the most established in terms of sex differences and already have a strong battery of tests and plenty of theory. This research has given many researchers reasons to look at what is happening with transsexuals. As a result, a plethora of related research is bound to appear in the next five years.

In Amsterdam, current ongoing research is replicating, and extending, the work done by Van Goozen. This work is being done by Ditte Slabberkoorn who is in the process of publishing some of her earliest findings

[14] Ekstrom's Card Rotations test consists of six two-dimensional figures. The first one is the example figure while the other five are either rotations or mirror-images of it. The participant needs to accurately select the rotated versions. Rotations are all in two dimensions. (Ekstrom, 1976)

[15] Vandenberg's three dimensional test consists of 20 items which are subdivided into two subtests. Correct answers were identical to the example figure but in a rotated position. Incorrect objects were mirror images of the correct images. Unlike Ekstrom's test, Vandenberg's tests are rotated in three dimensions and can be rotated in any of the six degrees of freedom. (Vandenberg, 1978)

(Slabberkoorn, 1999a). In addition, object recognition tests[16] are underway to test another element of cognitive processing. These tests are based on some preliminary work done in Canada. In Utrecht, Peggy Cohen-Kettenis is beginning to use functional MRI tests with adolescents to understand if hormones affect any element of cognition. Similar work with functional MRIs is being done in England. All of this research is just getting of the ground and most groups are just collecting data at this point (Slabberkoorn, 1999b; Van Goozen, 1999).

A Proposed Explanation

At this point, I believe that it is necessary to explain my beliefs regarding what might be occurring. The information in this section is based on my analysis of what is currently known and is not based on anyone else's theory. In order to validate this proposal, a series of experiments would be necessary.

At puberty, glands are stimulated causing a surge of hormonal changes in the body. These hormones affect the body changes but they also impact the brain and its processing. It is at this time when sex differences begin to come to light. Girls become less involved in sports while they become extremely conscious of fashion. Certainly, this occurs because of social expectations surrounding children, but the specific interests may also be related to the vision changes that are occurring at that time. At the same time, boys continue to improve performance in both sports and mathematics. Prior to puberty, children's strengths are rarely associated with their sex. In sports, school and other activities, girls usually perform equally as well as boys. This changes at puberty and I don't believe that it is entirely associated with social pressure.

Flow navigation is essential for sports. In sports involving a moving ball, understanding the position of the ball in relation to you is essential for performance. This information is best recovered through the trained use of identifying the position of the ball based on the speed in which it is moving toward you. In addition, while visuospatial ability and mathematics are frequently associated, I think that mathematical talent is also associated with one's ability to ascertain information about the world based on movement and object recognition. Flow navigation's intense dependence on trigonometry can only prep one's brain into understanding this. I believe that the interests of pubescent boys are also indicative of their strengthening visual ability.

On the other hand, girls become less focused on sports and more interested in art and fashion. (Again, I am not denying the social element to these interests nor the overgeneralization.) This stereotype may also be associated with the vision changes that occur in young girls at this age. Shape from shading allows for a heightened ability to recognize shading differences and object relationships. Although it is usually perceived as a joke, young girls are frequently aware of shading differences in clothing (those black pants do *not* match that black shirt) while

[16] Object recognition tests are used to see if one is aware when an object is shifted or is exchanged with another object. In Canada, Doreen Kimura found that men are better at recognizing shifts while women are better at recognizing exchanges.

young boys tend to be oblivious to this. In addition, females are reported to have more difficulty adjusting their night vision. Night vision eliminates ones ability to use shape from shading techniques to get reliable information because of the limited range of potential shades. Thus, if shape from shading is a main focus of the brain, it is necessary to switch focuses in order to see in the dark. For this reason, I think that females require more time to adjust to darkness and are slower at maneuvering in this type of environment.

So, how do these stereotypes help explain what is happening? I believe that, like many stereotypes, the explanation of the development of these stereotypes is biological in addition to cultural. In this case, I believe that the children's interests are partially associated with the hormonal changes that is occurring in their bodies, particularly with their vision.

I believe that the amount of hormones in the brain and in the retina is associated with one's primary visual technique. While I think that this naturally occurs at puberty, I also believe that it can vary with one's hormone levels and even with one's activities. (For example, a male artist is trained to focus on colors and shading. I would guess that he is more likely to focus on shape from shading techniques as a result.) When hormones are given to transsexuals to reverse their body hormonal levels, I think that this impacts the vision as well. I believe that there is a great potential for transsexuals to experience a flip in primary visual techniques due to hormones. Determining if, when and how this occurs is a much larger problem.

Experiments to be Conducted

Following are a few experiments that could be conducted to determine the validity of various theories addressed in this paper. Although this paper addresses vision theory, how it can be applied to transsexuals and ways in which transsexuals have experienced these possibilities, a methodological experiment is necessary to understand ways in which visual perception changes as individuals experience hormone changes. Due to a lack of time, I was not able to conduct these experiments in Amsterdam but I would like to propose how such an experiment would be conducted for future research.

Why Use Transsexuals

As I have mentioned before, transsexuals offer researchers the ability to see how the intake of reverse hormones affects the vision abilities. It is important to understand why this group is essential for this research.

Given the strength and quantity of hormones that transsexuals take, one can expect to see the most variation on tests that are hormone dependent. If any difference does exist in the general population, it will be clear and

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Ditte Slabberkoorn in Amsterdam attempted to repeat these results but was unable to do so. If she found a sex based

significant in the transsexual population. Should the hypothesis hold true with transsexuals, it is then logical to test across menstruation levels, through ages and in the general population.

In addition to this primary reason, it is important to note that with transsexuals, it is possible to have relatively consistent hormone levels amongst all subjects. To be certain what the hormone levels are, blood tests can tell us what the FSH, LH and testosterone levels are at all points. In MtF subjects, there should be no hormone variation over time while FtM subjects will have a varying level of testosterone in their system, dependent on when they took their last shot (or patch). Regardless, all of this can be easily accounted for and made consistent in order not to be an added variable.

Battery of Tests

One of the greatest difficulties with running this experiment is going to be that no accepted battery of tests currently exists, meaning that I will need to devise tests from scratch. Because of this, it will be necessary to run a pilot test to determine if I am testing what I intend to evaluate. Thus, the tests listed here are based on a basic understanding of what needs to be tested and how to administer such tests. Before an experiment would actually be done, the suggested tests would need to be reviewed by others in the field to prevent possible unintended side variables.

Sample

Four different groups would be used – male-to-female (MtF), female-to-male (FtM), and two control groups – male (M) and female (F). Approximately 25 of each category would be used for a quality cross sampling of individuals. The transsexuals will have been accepted for hormone treatment but will not yet have begun the hormones. The control group will come from the general population and will not identify as transsexual and may not have undergone any type of hormone treatment.

While the individuals would need to be post-pubescent and pre-menopause, the age range would be highly dependent on the transsexuals, as the control group should match the background of the transsexuals as much as is possible. More than likely, most of the participants would need to be in their 20s/30s/early 40s. Age of participants would be recorded.

The racial backgrounds of the control group should be similar to that of the transsexual group so as not to add another variable. Based on the location of such tests, a standard racial background would be ideal[17].

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difference, the men were always stronger (Slabberkoorn, 1999b).

[17] The cognitive tests done in Amsterdam used only Caucasian participants (Slabberkoorn, 1999b).

In order to eliminate possible side effects, individuals with intersexed backgrounds and variations in chromosomes will not be a part of this experiment. In addition, only those transsexuals who are undergoing complete hormone treatment will be accepted. In other words, MtFs who are starting with only antiandrogens or transsexuals who are not taking the normal doses of hormones will not be accepted for this experiment. Individuals who are taking hormone-altering medications (steroids, hormonal birth control) and individuals who are pregnant will be exempt.

General Procedure[18]

Individuals will be tested three separate times.

For transsexuals, the first test will be prior to the start of hormones. FtMs will be tested sex days following the start of their menstruation. The second test will be after three months of hormone treatment. FtMs will be tested six days following their last injection. The third test will be conducted after one year of hormone treatment. Again, FtMs will be tested six days following their last injection.

The control group will be tested in similar intervals – initial, three months later, one year later. Females will be tested six days after the start of their last menstruation.

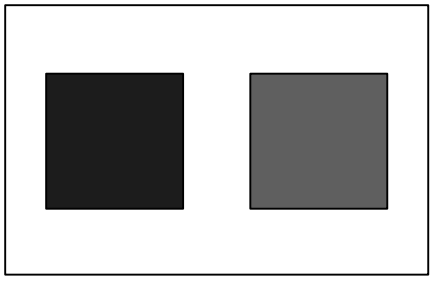
The tests will be given in the same order, with a break as needed.

The same room would be used throughout the testing process. The same tester would also be used.

Shade Differentiation

This test would be repeated twice, first on the computer and then on paper/pencil. This is to determine if the computer task affects an individual's ability to differentiate the shades. Theoretically, there should be no difference but since a battery of tests is not secured, it can only help to be certain.

Each individual would be given 40 pairings of squares, approximately 3 inches by 3 inches each, either on paper or on a computer. The background for the squares would be the same color on 30, either black or white. For the last 20, one square would have a black background while the other would have a white background. Some of the paired squares would be



[18] The general procedure mimics the procedures used by the Gender Clinic in Amsterdam when doing cognitive testing. This setup is considered to have consistent test results and to minimize external variables. Maintaining consistency in hormone levels is necessary for this type of test (Slabberkoorn, 1999b; Van Goozen, 1999).

exactly the same shade while others would be slightly different. All paired squares will be a shade of gray (i.e.: the same percentage of red, green and blue). The individuals would be asked if the square on the right is lighter, darker or the same shade as the square on the left. There will be no feedback given to the individual. The difference in shade of the squares would range in difference. The pilot test will be used to determine what a valid range of shades would be. A definition for lightness/darkness will be given. An extreme example can be seen on the right. This activity will have a limited time that needs to be determined during pilot tests.

I suspect an increase in ability by those treated with antiandrogens and no increase (and a possible decrease) in those treated with testosterone. Those without hormones will probably not improve.

Reaction Time

Using a computer, I would set up a reaction time test. The participant would know that one of the squares was changing shades slowly over time. When the participant recognized which square was changing shades, s/he would press the appropriate button. This test does not depend on determining shade but on shade changes and recognizing changes.

I suspect that testosterone-treated individuals will not improve on these tests while antiandrogen-treated individuals will see a remarkable improvement. I suspect that non-transsexuals will see a minimal increase in ability due to familiarity.

Night Vision Tests

Tests to determine ability of sight with minimal lighting could also be useful in evaluating visual changes due to hormones. First, a test of darkness adaptation would be used to determine if general adaptation is dependent on sex hormones (Harnois, 1986). Next, the individual would need to perform a task in a well-lit environment as well as a darkened environment. Fleshing out how this test would be conducted requires more research.

I suspect that testosterone is positively associated with adaptation time as well as performance in a darkened environment.

Computer Generated Worlds

More complicated tests, such as computer generated worlds, need to be fleshed out before they can be reasonably tested. An example would be to create a scene and have the participant do various activities. One thing could be that the participant would need to determine where the light source is. Another possibility is testing the user's ability to judge distance based on active participation. This type of test would need to be run

with varying levels of rendering. Such a test is currently out of the reach of the author, but is in the back of her mind.

Testing Concerns

Not surprisingly, these tests raise a great number of potential concerns. As with any cognitive test using people, unwanted variables are bound to creep into the test.

First, and foremost, the participant's feelings, motivation and personal situation are bound to affect hir desire to participate. In addition, hir relationship with the tester will play a role in hir performance. Eliminating these variables is practically impossible[19].

As with any test done on a computer, it is important to realize that emotions are signaled when an individual is forced to interact with a computer. Running identical tests on paper will help the researcher determine if the computer is going to play a significant role in these tests, particularly if the level of comfort is based on sex.

Artistic background may also alter one's performance on these tests. During the pilot period, it may be useful to see if individuals who study art outperform those who don't.

The familiarity effect needs to be accounted for in these tests. As participants get accustomed to the test they are given, over time, their performance should improve. Theoretically, though, the improvement of all participants should be similar in magnitude. This is an important concern to consider when analyzing the data. In addition, for this reason, it is important to run examples prior to testing so that the participant has a basic level of familiarity when the actual test begins.

Light source in the room could also play a role in one's performance. It is important to minimize distractions or variations in the room setting. Consistency is essential.

Although one's sightedness (perfect being 20/20) should not impact their visual processing techniques, it is quite possible that what is required for correcting this vision (contact lens, glasses) have an impact on this. For example, contacts magnify brightness. This must be considered.

[19] When I spoke with Ditte Slabberkoorn, she expressed many concerns related to these variables in the transsexual population. The individuals are tremendously focused on how their physical appearance is changing and their moods improve as their physical image becomes what they desire. In addition, when participants smoke, their performance can often be related to the time since the last cigarette. Such factors are a major limitation in this type of work (Slabberkoorn, 1999b).

It may be important to control for handedness (Gladue, 1995) and for sexual orientation (Gladue, 1995; Hall, 1995; Gladue, 1990).

Other potential concerns are addressed in a later section titled "Methodological Issues When Working with Transsexuals." That section is related purely to working with transsexuals on research but is not specific to these proposed experiments. All of the concerns in that section must also be addressed before proceeding with this research.

Concerns and Issues with this Research

This area of research is not without methodological and ethical concerns. The impact of doing any research is great and therefore, it is import to fully understand as many potential impacts as possible.

The Basic Assumption – Differences between the Sexes

Research such as what is proposed in this paper does have one major assumption – that there do exist differences between the sexes. This assumption automatically segregates people based on their beliefs, and makes a larger population uncomfortable, regardless of the findings. Suggesting that there are differences, even if the proof is inconclusive, gives society reasons to feel that there is a divide. Even the act of doing such research or suggesting such research reinforces these beliefs, making it difficult to break them down.

In addition, by creating this hypothesis, there is the possibility that people will identify with it (or against it) based on personal experience. As a result, regardless of the results, individuals who hear of this work will create their own conclusions of its validity, even before formal tests begin. This becomes a self-focused proof by example, where the individual either feels that the hypothesis is true or false based on hir personal experiences. This is problematic because, by creating this hypothesis, I am creating a discourse that segregates.

My goals and beliefs create a personal dilemma for me. While on one hand, I desperately want to understand how our mind and body works, I hate to think that I am continuing a discourse which promotes segregation and gives excuses for people's strengths and weaknesses. I don't wish to answer the mega-question, but rather to understand how the body works. I prefer to destruct sex by analyzing it in detail but I fear that I may be reinscribing an idea of binary sex for the masses.

Feminism and Queer Movements vs. Science

While one intention of researching this topic is to minimize man-made sexist objects, this type of research causes a great deal of concern amongst feminist and queer movements. Thus, it is important to address the

impact that such research would have on them. In addition, I offer some reasoning as to why there is conflict in thought between the feminist/queer groups and the scientists.

Unfortunately, historical mistakes have created a level of distrust between the feminist/queer communities and the scientific community. For that reason, any attempt by scientists to understand potential sex differences within the body, especially by using transsexuals, creates concern. While this concern is validated, it makes it tremendously difficult to do such research because of the social impact of such work. Such concern has segregated the various communities attempting to understand gender and sexuality.

Even within the scientific community, there is a splintered attitude regarding how the body is sexed. Endocrinology has been one of the primary areas in which sex differences have pervaded and determined distinctions have flourished.

> The reduction of sex differences to the chemicals that produce them, the notion of a sex continuum based on an ideal/defective dichotomy, and the belief in determining influence of endocrine function on personality and social role contributed to the medical view of the body as being sexed at the level of its chemicals and its behaviors. Endocrinology offered physicians and others seemingly definitive proof of the pervasiveness of sex in the body and personality of human subjects. (Hausman, 1995, 42-3)

While these distinctions may have convinced many people that there is a divide between male and female, it has also convinced others that science is inherently wrong and biased and thus not worth addressing.

One area of cognitive science has already been a part of this scrutiny – those who are trying to determine if there is a sex-based difference regarding visuospatial skills. As a result, hundreds of publications have been written addressing this topic, either trying to validate it or find holes in the theory. This is also one of the reasons that research on this topic using transsexuals has been quite important as an attempt to eliminate potential methodological errors.

While there has been considerable progress within the endocrinological and cognitive science fields in determining sex-based differences, the feminist and queer movements do not acknowledge what these findings could mean, except to say that the methodology is flawed. Findings of sex differences are disregarded as an attempt to permit segregation as a natural occurrence. Certainly, in a historical perspective, this is logical, as the science community has forced both females and sexual non-conformists to take a backseat position in related discussions.

Unfortunately, at a point where communication could be useful for the improvement of understanding in both communities, the ability to communicate does not exist. Instead, there exist two vastly different cultures of intellectual thought concerning the topic of sex. This gap does not appear to be narrowing, even with the acknowledged advantages of communication.

Personally, I find neither group to have answers to the problems that I raise. Thus, I feel that the only way for improvement in research is to open the lines of communication between the two fields. In the meantime, I hope that I am able to do this type of research without angering the feminist and queer movements, and preferably I would like to have their support.

Methodological Issues when Working with Transsexuals

While the transsexual population offers a unique group with which to learn more about how the body works, the methodology is not as strong as desired. The transsexual population is the largest group with which experimental research on human endocrinology is possible[20]. While it is possible to monitor amounts of hormones given to individuals, it is unfeasible to veer away from the treatments given to them to address transsexualism. As a result, placebo tests are impossible. Transsexuals must go through a grueling process in order to have access to hormones; a placebo would be unethical. In addition, the transsexual would notice pretty quickly as the results are practically immediate (Van Goozen, 1994a). Thus, in order to do any research involving transsexuals, it is important to stay within these constraints.

In addition, it is important to remember the focus of these patients. Their primary goal and focus is a change in external appearance. Transsexuals rarely recognize cognitive changes, unless their jobs or hobbies depend on it. In addition, it is important to make certain that the tests cannot be done in a way in which the individual thinks s/he should perform.

While it has been quite possible to do longitudinal studies of transsexuals in Holland, this is not possible everywhere. In Holland, transsexual therapy is covered by health insurance and there is one Gender Clinic, a part of Vrije Universiteit in Amsterdam. Most transsexuals who go through their transition at the Gender Clinic stay with the Team for the remainder of their life. The United States is an example where this is not true. There are many gender teams throughout the States and most transsexuals do not stay attached to one team but search for a more acceptable or cheaper alternative. This makes conducting long-term studies difficult outside of the Dutch context. [Even researching what has been done would have been virtually impossible without the researchers on the Gender Team.]

Although minimal known differences exist between non-transsexuals and transsexuals, it is important to acknowledge that individuals who identify as transsexual may have chemical or biological differences that are unnoticed but regardless, affect the outcome of any tests. In addition to scientific differences, there may be

[20] There are other groups who receive hormone treatment to combat cancer or to adjust normal human levels. None of these groups receive a complete reverse hormone treatment.

socialization and cultural differences in these people as a result of gender dysphoria that make them poor subjects for such an experiment.

Transsexuals are also experiencing tremendous amounts of stress and psychological issues during this period of time (Cohen-Kettenis & Gooren, 1992), potentially making them inappropriate subjects.

It is also important to remember that the hormones affect the outlook of transsexuals, their social activities and interests could be heavily altered, providing a complication in understanding what is actually happening. For example, if an FtM is suddenly feeling more comfortable about himself and is willing to go out and socialize with "the boys" and in doing so, spends a great deal of time on video games while he never used them before, he is going to strengthen different areas in his visual ability, having nothing to do with testosterone. This type of complication is difficult to control for.

Political Implications of Using Transsexuals

Using the transsexual population for scientific research has political implications as well as methodological ones. First, it must be acknowledged that, while information that impacts the hormonal treatment of transsexual may be found, the main purpose of this type of research is general understanding. With that in mind, using transsexuals for general-purpose research can be perceived as an abuse of the transsexual population. Since medical sciences gain from using this population, it becomes more difficult to recognize transsexuals beyond the implied 'illness.' As a result, such research only continues the dominant paradigm's perception of transsexuals as deviant. Thus, it is important that if such research is useful, the individuals used are recognized and validated, not just used as medical specimens. It is important for the medical practice to look beyond the advantages of learning from a population and recognize the implications of their actions.

In addition, it is quite possible that, because transsexuals are viewed as 'deviant' and 'unnatural,' using them in a study might discredit the study. This is quite inappropriate and should be reviewed.

Conclusive Remarks

This report is left open-ended, awaiting further research. At this point, it is impossible to fully discuss the interplay between vision and sex hormones, even within the transsexual subject. Both current research and researchers indicate that such a relationship is highly likely but to what degree, no one is certain. Although it is currently untested, I believe that enough indicators exist to warrant further research. First, methodologically sound tests are essential for getting a firm grasp of the potential relationship. The use of transsexuals provides insight that is otherwise difficult to ascertain. Second, after finding appropriate tests, research should be conducted on a wide variety of individuals whose bodily makeup could help give information for understanding how sex hormones affect visual processing. Only after a quantity of research has been conducted is it possible

to evaluate my hypothesis. Until then, I hope that this paper has given the reader a decent level of familiarity with the topic and the research potential. In addition, while I can theorize about potential impacts, until the necessary research is done, it is impossible to be certain what the resultant impact would be.

Appendix – Glossary

This glossary is intended to help you read this paper. The definitions of the terms here are as I have used them in this paper and are not necessarily the accepted definition for the term, particularly when the definition is debatable.

androgen – generic term for an agent, usually a hormone (e.g., androsterone, testosterone), that stimulates activity of the accessory male sex organs, encourages development of male sex characteristics, or prevents changes in the latter that follow castration; natural androgen's are steroids, derivatives of androstane (*Stedman's*, 1995)

antiandrogen – any substance capable of preventing full expression of the biological effects of androgenic hormones on responsive tissues, either by producing antagonistic effects on the target tissue, as estrogens do, or by merely inhibiting androgenic effects, such as by competing for binding sites at the cell surface (*Stedman's*, 1995); given to male-to-female transsexuals to combat the androgens within their system; examples include cypertone acetate

aromatase – enzyme that converts testosterone to estrodiol

cypertone acetate – a steroid with antiandrogenic and progestational capabilities; works by inhibiting the hypothalamo-hypophyso-gonadal axis and blocking LH and FSH secretion in men and women, causing decreased levels of testosterone in males and inhibited ovulation in females; inhibits the secretion of gonadotropins and indirectly decreases sex hormone secretion (Dollery, 1999, C370-C372)

DHEA – dehydroepiandrosterone; an important precursor to the androgen hormones; in particular, DHEA is converted to testosterone (Morris, 1999)

endocrinology – the science and medical specialty concerned with the internal or hormonal secretions and their physiologic and pathologic relations (*Stedman's*, 1995)

estrogen – generic term for any substance, natural or synthetic, that exerts biological effects characteristic of estrogenic hormones such as estradiol; estrogen's are formed by the ovary, placenta, testes, and possibly the adrenal cortex, as well as by certain plants; stimulate secondary sexual characteristics, and exert systemic effects, such as growth and maturation of long bones (*Stedman's*, 1995); causes secondary sex characteristics such as breast growth, female-typed pubic hair growth, hip growth and positioning of fat in a female-typed manner on the body

female – an individual whose sex hormones consist primary of estrogen, usually at a level greater than 40 pg/mL

female-to-male transsexual – an individual who was previously defined as a female but is currently defined as a male because of a hormonal change in the body

FSH - follicle stimulating hormone; a major sex hormone released by the pituitary gland; stimulates the development of the ovarian follicle in females and controls an important stage in the menstrual cycle (an FSH surge triggers and estrogen surge which triggers ovulation) (Morris, 1999)

gynecomastia – excessive development of the male glands, due mainly to ductal proliferation with periductal edema; frequently secondary to increased estrogen levels, but mild gynecomastia may occur in normal adolescence (*Stedman's*, 1995)

hir – single, non-gendered possessive to replace him or her

HRT – hormone replacement therapy

in-between – an individual whose hormonal makeup does not fit into either male or female or whose hormonal makeup fits into both male and female; this person may be in the process of a transition but not necessarily

LH - leutenizing hormone; one of the two major sex hormones released by the pituitary gland; stimulates the production of testosterone in males and controls the menstrual cycle in females (along with FSH) (Morris, 1999)

male – an individual whose sex hormones consist primarily of testosterone, usually at a level greater than 225 ng/dL

male-to-female transsexual – an individual who was previously defined as a male but is currently defined as a female because of a hormonal change in the body

progesterone – a naturally occurring progestogen steroid (sex hormone) in the female body secreted by the corpus luteum; helps estrogen menstruation, pregnancy and breast growth but is related to abnormal liver functioning, hormone dependent carcinoma, weight gain and acne (Dollery, 1999, P229-P231); an antiestrogenic steroid, believed to be the active principle of the corpus luteum, isolated from the corpus luteum and placenta or synthetically prepared (*Stedman's*, 1995)

prosopagnosia – an inability to recognize faces, regardless of familiarity while completely capable of distinguishing between objects; this neurological disorder is frequently used to prove that there are multiple parts of the brain that address object recognition depending on whether the object is organic or not

s/he – single, non-gendered pronoun to replace she or he

steroid – a large family of chemical substances, comprising many hormones, body constituents, and drugs, each containing the tetracyclic cyclopenta[a]phenanthrene skeleton (*Stedman's*, 1995)

SRS – sex reassignment surgery

testosterone – a steroid androgen that is secreted by the Leydig cells in the intertubular tissue of the testis; primary sex hormones in males (other androgens are secreted by the adrenal glands but this is not enough for males); effects of testosterone include: growth of external enetalia, increased muscular mass, lengthening of the vocal cords due to growth of laryngeal cartilage, increased skin thickness and oiliness, increased hair (facial, body, axillary and pubic), ill-defined central nervous system changes that result in a stimulation of the libido, clitoromegaly (in women), male-pattern baldness; potential problems due to testosterone include: overt cardiac failure, peliosis hepatis (blood filled cysts in the liver), acne (Dollery, 1999, T56-T60); the most potent naturally occurring androgen, formed in greatest quantities by the interstitial cells of the testes, and possibly secreted also by the ovary and adrenal cortex; may be produced in nonglandular tissues from precursors such as androstenedione (*Stedman's*, 1995)

Appendix – Survey for Transsexuals

This survey is intended for individuals who have undergone hormone treatment to address transsexualism. Any individual who has started hormone treatment is welcome to answer this survey, regardless of when you started treatment or whether you later switched to balancing hormones or stopped the process altogether. The questions are intentionally open-ended as to allow you to discuss what you have experienced in an unstructured manner. The more details you offer, the more useful the information is for me. The information gathered in this survey will be used to help me have a better understanding of how hormones affect one's cognitive processes.

My name is Danah Beard and I am currently studying gender and sexuality in Amsterdam, through the School for International Training. The work that I am doing regarding cognition and transsexuality is for an independent study for the School for International Training. I come from the United States and I am working on a degree at Brown University. I can be contacted through various means. My email address is dmb@cs.brown.edu and my current phone number is 020.612.8190.

All information acquired through this survey will remain confidential. Should you want to give me more information, either in confidence or on-the-record, feel free to email me or give me a call. If you have any questions, do not hesitate to contact me.

What hormone treatment have you undergone?
___ testosterone
___ anti-androgen
___ estrogen
___ progesterone
___ other

Please describe the treatment that you underwent, including how long you took the hormones, how much hormone you took, how you took the hormone (i.e.: injection, pill, etc.). Also, include the approximate date when you started hormone treatment. If your hormone plan has changed, please describe why and what changes were made.

Have you noticed a change in any of the following (either for the better or for the worse)?
___ night vision abilities
___ clarity/brightness of colors
___ spatial relations
___ concentration
___ range of hearing
___ strength of smells

If the answer to any of the above questions was yes, could you please explain what changes you have noticed?

In addition to the previous statement, how do you feel that the hormone treatment affected your cognitive processes (such as vision, hearing, thinking, etc.)? What changes did you notice in terms of your mental abilities? Please describe the changes that you experienced with as much detail as you can remember. Please attempt to focus on how the hormones affected you rather than how the psychological or social impact may have affected you. If you don't feel as though you can separate the two, please make that clear.

Is there any other information that you would like to add?

Would you be interested in answering more questions or allowing me to ask follow-up questions?

If you don't mind being contacted, please include your name and contact information.

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Acknowledgements

I would like to thank all of those who supported me during this work, both in Amsterdam and abroad.

Martijn, Jos, Henk, and all those interviewed and surveyed – thank you for helping me with this project and getting my mind rolling. Hopefully, we can do it again!
Gabriel, Martijn, Abby/Abi and Neil – editing is appreciated tremendously.
Ginni and group – thanks for stretching my beliefs and making me reconsider my thoughts.

Finally, I would like to address a few individuals who have provided mental support, above and beyond the call of duty.

To Ky, for complications, methodology & PBE, "vision" and someone named Alex. Where on earth did you put it??? Its lost again. No, English is *not* the reason that you can't find it.
To Gabriel, for smurfs and caterpillars, culture, "girls" and Meg Ryan's cuteness. I am so glad that I can make you smile.
To Jon, for eternal support and copying abilities. Four months is nothing compared to a lifetime. I will always be *your* dyke. <GRIN>
To my mother and brother, how can I begin to thank you for everything?