Running Head: GENDER OF SCIENCE

Blue is for Boys, Science is for Boys, What's for Girls? A Critical Look at Gender
Constructs in Science Toys

By

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Abstract

Canadian born women are severely underrepresented amongst science students and researchers in Canada. This is due in part to the cultural construction of science as "unfeminine" and "for boys." Educational toys are often the first avenue in which children are introduced to and engage with scientific culture. Parents have traditionally used gender symbols in toys to teach children gender roles, appropriate values and actions. The current study investigates the possibility of science toys as a socializing agent for gendered beliefs about science. It does so, by completing a content analysis and qualitative analysis of the pairing of gender and science symbols within 400 science toys. This analysis found that science toys contained a substantial number of masculine symbols. Overt symbols such as boys alone on the package occurred three times more often than girls. Feminine mentors were symbolically annihilated among all disciplines making up less than 10% of all scientists. Covert symbols such as masculine shades, themes and child absent from the package were more common than gender neutral or feminine themes. Finally, the use of masculine symbolism differed by discipline, pointing towards several sub-cultures in science representing different degrees of adherence to masculine symbolism.

Key words: women and science, culture of science, socialization of children

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Table of Contents

Abstract.....	i
Acknowledgments	ii
List of Tables	v
List of Illustrations.....	vi
Chapter 1: The Problem of Fit between Girls and Science.....	1
Chapter 2: Gender, Science and their Symbolic Relationship	5
2.1 The Construction of Gender	5
2.2 The Construction of a Gendered Science.....	15
2.3 Promoting Science to Youth.....	20
2.4 Developing Science Interest	25
2.5 Gender Symbolism in Promotional Content	29
2.6 Gender Symbolism in Toys and Educational Media	39
Chapter 3: Methods	45
3.1 Methodological Perspective.....	45
3.2 Social Location and Researcher Perspective	47
3.3 Dependability and trustworthiness.	49
3.4 Sample and Coding	51
3.5 Measures	54
3.5 Analysis	64
4 Chapter: Findings	67
4.1 Target	67
4.2 Mentors	82
4.3 Gendered Content and Discipline Trends	88

Chapter 5: Summary of Findings.....	93
Chapter 6: Conclusions	95
6.1 Science Culture as a Whole.....	95
6.2 Science as Multiple Cultures.....	105
6.3 Limitations.....	114
6.4 Future Considerations	115
6.5 Uses for Research.....	116
References.....	118
Appendix A: Code Book-Short Form	133

List of Tables

Table 1: Dichotomized Concepts Attributed to Gender Categories	9
Table 2: Gender Symbols for Targets and Mentors	56
Table 3: Target Codes	57
Table 4: Mentor Codes	61
Table 5: Toy Codes	63
Table 6: Child Absent versus Present by Discipline	68
Table 7: Target Gender by Discipline	70
Table 8: Number of Targets by Discipline	76
Table 9: Comparative Analysis of Masculine Mentors by Discipline	85

List of Illustrations

Illustration 1: Prominence of Characters	80
Illustration 2: Masculine Targets Portraying Active Stance	80
Illustration 3: Feminine Targets Portraying Passive, Audience Focused Stance	80
Illustration 4: Depiction of Expert and Novice Roles	81
Illustration 5: Depictions of Masculine Mentors.....	86
Illustration 6: Depictions of Feminine Mentors	86
Illustration 7: Themes for Botany Toys	90
Illustration 8: Themes for Astronomy Toys	91
Illustration 9: Feminine Themed Content	92

Chapter 1: The Problem of Fit between Girls and Science

A young girl walks into a toy store and before her mother can even read the sign ‘Girls Toys’ she will have found the section. Despite the fact that the young girl cannot yet read the words of her native language, she is fully literate in the symbols and cultural representations of her gender. She knows that pink is a girls’ colour; that rainbows, flowers, hearts and bows are symbols for girls and the media they appear on are *for her*.

This thesis investigates whether science toys are also symbolized as *for her*. I investigate this as part of a greater debate on the construction of science as symbolically anti-feminine. In general, the sentiment that science is masculine appears before girls even enter a science classroom and emerges in tandem with the gradual formation of their gender identity. At the age when girls form a consistent understanding of themselves as gendered, around six years old, they describe science as ‘not what girls do’ and ‘for boys’ (Baker & Leary, 1995). As their knowledge about gender roles and career appropriateness is formed, around age nine, girls rule out science as a possible career choice (Farenga & Joyce, 1999). Finally, when girls are first able to act on their gendered preferences in the educational arena, a large number of them drop science study, because it doesn’t fit their interests (Osborne, Simon, & Collins, 2003; Hewlett et al., 2008).

According to the Colman report for education equity (1966), a student’s performance and their likelihood of succeeding are most affected by social factors. This includes the support of parents, teachers and peers and the ‘fit’ of girls to the student identity (Dorsen, Carlson, & Goodyear, 2006). Students own confidence in their abilities, their resiliency and their interest are all influenced by cultural negotiation (Hodkinson & Sparkle, 1997; UNESCO, 2012). Basically, students need to believe they are capable of navigating the system and aligning with the priorities

of those within it. As such, the idea of ‘fit’ between the perceived gender norms of a discipline and hopeful students, has been found to have lifelong effects (Hanson, 2010).

The problem of ‘fit’ is a part of a wider debate regarding the underrepresentation of women in science. Women have been found to make 37% of students, 22% of scientists in Canada (NSERC 2010) and 28% in the world (UNESCO, 2015). In chemistry, physics, astronomy, math, engineering and computer science women make up about 15% of full-time faculty positions in Canadian universities (CCA, 2012). In biology, a field dominated by women at the undergraduate level (69%), women scientists are still underrepresented and make up only 35% of faculty members (CCA, 2012). This change in representation occurs gradually with students dropping out at every educational stage.

In the case of biology women dominate every student stage, but become underrepresented when they move into employment (NSERC, 2010; CCA, 2012). In general, a disproportionate number of women with PhDs in science are unemployed at every stage. This problem is most pronounced before the age of 39, when women first graduate; at this time they make up 63% of the unemployed pool of workers in these fields (CCA, 2012). These numbers becomes less stark as women leave these fields to look for work elsewhere (Hewlett et al., 2008).

According to Julie Goodfellow (2001), the first female head of research in the UK, the tendency for girls and women to leave science at every career juncture is like a leaky pipeline. She suggests that these leaks are an artifact of constant minute discouragements, or cultural pressures that aid in pushing girls and women out of science. This pressure is considered to be multi-model and originating from both science culture and the greater Western culture. Both, which depict science as masculine (Fox, 2006). In other words, the problem of ‘fit’ is not only

‘death by a thousand cuts;’ but a problem of cultural construction that creates an artificial difference between the identity of girls and science enthusiasts (Goodfellow, 2001).

Socio-cultural theory postulates that these discouragements are a ramification of cultural disparities caused by polarized definitions of gender categories (Lent, Brown, & Hackett, 2000; Dorsen, Carlson, & Goodyear, 2006). The formation of these categories begins when a gender label is assigned at birth and gain polarized meaning through socialization (Grohmann, 2009). Toys are one of the major socialization agents used to create these polarized definitions. Particularly, toys use colour, gendered themes and gendered characters to teach children gendered interests, value emphasis and roles (Liben & Bigler, 2002).

Toys also affect a child’s sense of identity as a student and as a person. For example, exclusionary promotional content within toys have been found to lead to an ‘othering’ identity in underrepresented groups (Clarke & Clarke, 1947; Powell-Hopson & Hopson, 1988; Holmes, 2003). Specifically, people who felt like an ‘other’ held negative attitudes about their capabilities and self-worth in relation to promoted activities (Holmes, 2003).

According to the theory of possible selves, these subtle social reinforcements, when combined with gender symbolism and societal expectation can eliminate future career paths long before they are imagined (Dorsen, Carlson, & Goodyear, 2006). Substantial evidence for this theory has been garnered by analysing the social exchange between parent and child regarding career related topics and studying the content of gendered toys. Despite these findings and the importance of toys in socializing gendered meanings, this medium has received little attention from the scientific community.

Very little information on the uptake of science toys, kits and related activities; or the gendered content within them has been completed. Yet, science toys were rated as the third most

influential source for cultivating youth science interest by students in science disciplines (NSERC, 2015a). This thesis explores science toys as a medium for conveying gendered meaning and looks to investigate early gender socialization as a tool for directing gendered ideas about science uptake.

Chapter 2: Gender, Science and their Symbolic Relationship

2.1 The Construction of Gender

To begin to understand the relationship between gender, science and toy symbolism these terms must first be contextualized and defined. Smith (1992) described gender as having “more orienting force... than any other human differentiation” (p.36). Gender organizes nearly every avenue of social existence, from conception to death. It affects parental socialization, skill building, activity preferences, peer acceptance, educational and employment opportunity and much more (Leaper & Friedman, 2007). Despite the power of gender in organizing and directing the lives of individuals and societies, it exists as a nearly invisible structure of taken for granted cultural practices (Lorber, 1994; Bailyn, 2003). These practices appear in the symbols, traditions and the material culture of a society, as well as the actions, interests and aspirations of individuals (Baxter, 2005). Due to the wide spread acceptance of these practices and the interwoven nature of such beliefs into every societal structure, their effects are often unseen.

Dominant binary perspective. The invisibility of gender in societal structures is the work of the dominant binary understanding or ‘natural attitude’ (Garfinkel, 1967). This theory incorporates a series of axioms about gender, which are taken up by society and deemed to be unquestionable or fact. This is due in part, to their presumed relationship to genetics, an element of science, which is deemed unchangeable (Udry, 1994; 2000). It is also due to the position of science in societal structures. As will be discussed in subsequent sections, science is a major knowledge producer in society and creates many of the belief systems that underpin cultural understandings (Cozzens & Woodhouse, 1995; Ma, 2012). Scientific claims maintain an elevated status within knowledge production, therefore, linking a phenomenon to biology or science also makes it appear ‘factual.’

In the dominant binary theory, these fact-like assertions centre on five main themes. They include the belief that two genders exist, that no natural variation exists outside of these categories and little variation occurs within them (Hawkesworth, 1997). It also postulates, that these categories are naturally opposing and biologically determined (Udry, 1994; 2000). Accordingly, the dominant binary perspective states that everyone is ‘naturally’ classified into a gender category based on their sex. That compliance with the designated roles and actions attributed to one’s sex is healthy, natural and desired. Finally, deviation from these categories is defined as a form of pathology, which is constructed as undesirable or unnatural (Hawkesworth, 1997).

The words ‘male’ and ‘female’ are used to denote sex, which is a biological term that refers to the categorization of a person based on genitalia (Scott & Marshall, 2009). Differences in genitalia are attributed to genetics or X and Y chromosomes. These chromosomes create variations in the way reproductive organs and several other bodily systems develop and function (Arnold, 2004). This includes the formation of sex hormones, which control several internal drives that regulate emotional and motivational responses (Arnold, 2004).

Gender is defined as the actions and preferences that are attributed to genetic and hormonal differences between males and females. These gender variations are called ‘sex differences’ (Scott & Marshall, 2009). Due to the presumed causal relationship between sex and gender, sex differences are considered synonymous with gender differences in this perspective. The association of gender and sex also means that genitals are considered the fundamental sign of gender (Udry, 1994; 2000). Hence, male genitalia dictate a presumption of masculinity or actions and preferences attributed to maleness. In contrast, female genitalia dictates feminine gender or actions and preferences attributed to femaleness (Davies, 2003).

As reproduction and copulation dictate complimentary functions of sex organs, sex is presumed to be complimentary or oppositional (Arnold, 2004). This relationship is maintained in the construction of gender and of sex differences. Thus, the assumed relationship between sex and gender contributes to the dichotomization of human traits creating two distinct classes of people (Butler, 1990).

By attributing a trait to a given gender it inherits a polarized relationship that negates its inclusion or appropriateness for the other gender. This creates two groups of roles, actions, values and interests called gender schemas¹. These schemas act as roadmaps for gender, defining what is deemed acceptable or ‘natural’ for a given sex (Kritensen & Label, 1999).

These gender schemas were often created or legitimized through scientific writings, which studied and dictated what behaviours were normal for men and women. Within this dichotomy, men were defined by their engagement with, manipulation and domination of the natural world (Ma, 2012). Women on the other hand were defined by their relations and service to men and children; and were considered entities of the natural world (Iyer, Sen, & Stlin, 2008).

The dichotomization of traits and their presumed natural causes, are important for situating the dominant binary perspective as a theory. These propositions reinforce the gender hierarchy within society as natural and unchangeable (Bleier, 1984). It also means that the differentiation between roles, which allot men higher status in society, is positioned as a form of natural selection, which justifies their domination of society and women (Keller, 1985²; Fox,

¹ Gender schema is usually used within the socio-culture perspective to name the grouping of traits and actions attributed to a gender. There is not an equivalent word within the dominant binary theory, thus, this word was used to express the same idea within this context. It was done so with the assumption that the cultural determinism related to the term would not be applied, in this case.

^{2 2} This is a milestone book in the field of women and science, which is referenced by the majority of current day scholars when discussing the masculine hegemony of science. I have included a few modern day references accompanying it, however these texts and the majority of other texts quote this book directly. I provide only the original reference for each subsequent citation, so that original meaning can be reviewed.

2006; Bevan & Learmonth, 2013). This domination narrative is without coincidence the exact set of constructs used and reinforced within the scientific realm (Bleier, 1984). These ‘facts’ look to uphold the current societal system, which deters women from gaining access to powerful roles including that of knowledge producer and scientist.

These meanings are also found to uphold the gender hierarchy within science culture, creating a problem of underrepresentation (Garner, 2001). This is done by removing the problem of equity from the social and cultural realm and instead explaining it biologically (Garner, 2001). Consequently, inequality is legitimized by naturalizing the problem and blaming it on the bodies of women. It does this by framing the problem as a direct result of the choices of women (Jefferson & Klye, 2008). While subsequently linking these choices to the expression of differentiated emotional and motivational responses caused by sex hormones (Udry, 2000; Arnold, 2004).

This distinction is especially important because the hormones of women have been constructed throughout scientific history as ‘out of control,’ or dictating their behaviour (MacCormack & Strathern, 1980). The hormonal argument against women has been used in nearly every facet of society to justify their lower social status and lack of fit to leadership roles. This hormonal claim is rarely made of men (MacCormack & Strathern, 1980). This occurs, despite the fact that the dominant binary theory proposes that the choices of all people are influenced by genetics and hormones (Hawkesworth, 1997).

In general, the genetic basis for traits and actions of men are often cited to explain excellence where the biology of women is used to explain irrational behaviour, incompetence and rationale for their subordination (MacCormack & Strathern, 1980). The most common

dichotomies contributing to this trend can be found in Table 1. These concepts will be discussed throughout the paper, as they are interwoven into scientific culture and gender socialization.

Table 1 Dichotomized Concepts Attributed to Gender Categories

Masculinity	Femininity
Active	Passive
Courage, risk taking	Vulnerable, fearful of risk
Strength	Weakness
Culture or individual determination	Nature, biologically bound or determined
Rational and un-emotional	Emotional or mad
Overt sexuality	Sexual passivity, purity
Worldliness, exploration	Naivety
Intellectual Prowl	Social Prowl
Provider of resources and economy	Provider of nurturance
Tough and rugged	Delicate and beautiful
Proponent of the public realm	Proponent of the private realm
<u>Cf. Gender Identities (2013)</u>	

It is important to note, that all of these meanings originate from scientific writings. Scientists have been found to extrapolate evidence of genetic causation of gender from a series of far-removed biological relationships such as the dichotomy of the egg and sperm (MacCormack & Strathern, 1980). The differentiation of gendered behaviour is typically legitimized through difference in sexual reproduction and the value assigned to such roles through scientist speculation (Keller, 1987). Several theorists have called into question the ways in which these sex differences have been interpreted and expanded on to make sense of and justify the current gender hierarchy (Keller, 1985).

It is worth noting that the scientists responsible for defining nature and gender were and still are primarily men (NSERC, 2010). According to Schachtel (1959) “nature is to man whatever name he wants to give her. He will perceive nature to the names he gives her, according to the relations and perspectives he chooses” (p.202). Historically, the position of men as those constructing the meaning of nature, has meant that such definitions reflected masculine interests and biases (Daniels, 2008).

Bleier (1984) describes the sociobiologists responsible for these meanings, as perceiving themselves as a *universal* reference point, equivalent to humanity as a whole. As such, “He and his fraternity become a norm which all *others* are measured and interpreted” (p.23). As a result, characteristics typically attributed to men are defined as normal or valued. Femininity by virtue of its opposition to masculinity, is constructed as devalued, not normal or lacking (Ehrenreich & English, 1978; Balsam, 1994). Through these definitions, science not only reinforces but expands the gender stratification both within science and the greater society (Keller, 1985).

The dominant binary perspective is heavily criticized in feminist and socialist literature (Keller, 1985; 1987; Butler, 1990). Essentially, if gender was biologically bound, gendered traits, actions and preferences would remain static across a gender category regardless of culture. Changes in gender would only occur if biological changes occurred. Similarly, if choices or preferences for science were dictated by sex hormones then representation should not differ drastically between cultures and changes should be observed between fertile and menopausal women.

The actions, behaviours and preferences of women do not change when their levels of sex hormones drop off (Hall, 1995). The preference for or participation in, science by women varies greatly between societies (OECD, 2014). Furthermore, hundreds of years worth of research and case studies highlight the existence of people outside these designated sex and gender categories (Mayour, 2006). Depending on the culture, between 2 and 29 distinct genders have been found to exist in human societies (Mayour, 2006). Moreover, the meanings attributed to each gender are not uniform and the traits and actions considered to be masculine in one society, may also be used to define femininity in another (Chafetz, 2006). Thus, defining gender into concrete binary terms fails to reflect the spectrum of human characteristics or the social realities of many

cultures. As such, this theory should theoretically be rejected by the scientific community as substantial empirical evidence supports its counter arguments.

Socio-cultural theory. Despite the overwhelming scientific evidence surmounted against the dominant binary perspective, this theory is still propagated and endorsed by the scientific community (Udry, 1994; 2000; Davis, 2003; Arnold, 2004). Due to the pervasiveness and persistence of the binary theory, it is suggested that gender meanings are linked to and reproduced through powerful cultural forces (Dutro, 2002; Chafetz, 2006). In this thesis, I argue that science culture conveyed through gendered symbols early in the socialization process aid to create a mismatched identity. In doing so, it eliminates ‘choices’ long before a young woman is faced with them, recreating a gender stratified society (Baker, 2009).

To begin to unravel this theory and its implications gender must be redefined. Within the socio-cultural theory, gender was a term created specifically to disassociate gendered traits and actions from biology. It suggests that cultural ideas about gender are conveyed and socialized into a child based on a label assigned to them at birth (Oakley, 1972; Chafetz, 2006). In other words, a child is differentially socialized, perceived and encouraged based on their sex. As a result, the inequalities that girls, women and gender non-conformists face based on gender, are the consequence of cultural and institutional biases that look to maintain masculine dominance (Chafetz, 2006)³.

³ The socio-cultural theory recognizes the existence of genders and sexes outside of the binary perspective. People who are outside of the gender binary can identify with many labels, I have labeled this group non-conforming in this paper. I do so with the recognition that this is a far from perfect label that does not depict the complexities of gender identity within this group. However, for the purpose of this paper I use this term to provide a counter argument and critique against the portrayal and uptake of the dominant binary understanding in scientific and toy culture. The limitation of my discussion to feminine and masculine, is due to the prominence of the gender binary in these fields. Also I would like to note that my use of the terms woman, girl, feminine, man, boy and masculine is purposefully removed from the categories of male and female.

Socio-cultural theory highlights that Western society is a patriarchy or system built on male domination. As such, this hierarchy serves to subordinate women and superordinate men (Scott & Marshall, 2009). By defining valued characteristics in terms of masculinity and defining femininity in opposition it creates an impossible system for feminine advancement (Chafetz, 2006). Women must match these valued characteristics in order to gain access to opportunity, but doing so means exiting appropriate gender roles and identity. In this way, gender acts both as a barrier to women and a regulatory function that seeks to maintain and reproduce the patriarchy.

To better understand this process we must first define a few terms. Gender roles are a set of prescriptive expectations regarding the appropriateness of actions and interests for men and women (Barrett, 1980). They are culturally-specific and taught to children through the socialization process, usually through the use of toys and role-modeling. The goal of this socialization process is to help a child form a gender identity that coincides with societal values. Gender identity refers to an individual's sense of self as masculine, feminine or another gender (Hawkesworth, 1997). There are various levels of agreement or disagreement between the identity of a person and the prescribed roles of their gender. This is called gender-role identity. This is the extent to which a person takes up and believes in the designated actions deemed appropriate for their gender (Hawkesworth, 1997).

As previously suggested, within a patriarchy valued characteristics are ascribed to masculine roles (Schippers, 2007). By virtue of oppositional gender constructs, these roles defy the definition of feminine identities. This leads to either a matched gender-role identity, where women give up roles that do not fit their feminine identity; or lead to a *miss*-matched identity where women maintain both the role and gendered identity but experience internal and external barriers due to their lack of fit (Hawkesworth, 1997).

This has three important implications for this paper. Firstly, women can take up these valued activities, actions and characteristics. Secondly, they are punished socially for doing so. Lastly, this regiment of societal punishment transforms gender into a set of protective actions rather than an innate or valued response.

To begin, women can and do, take up traits and activities that are categorized as masculine, in order to access the privileges, careers and resources traditionally held by men. Therefore, masculinity and femininity can be a ‘performance,’ where an individual can move into and produce it by engaging in gendered practices (Connell, 2000; 2012). For example, a woman can portray masculinity by appearing unemotional, taking risks and engaging in aggressive acts (Schippers, 2007). Although one of these characteristics alone would not make her appear masculine, combining them would create a cohesive masculine performance. Consequently, gender cannot be considered a static characteristic that one possesses based on biology or sex (Fox, 2006).

As performing masculinity violates the subordination of women, those who perform it may experience a form of punishment for stepping outside of their designated societal role (Butler, 1999). Thus, performing valued masculine actions such as being ‘hard working’ and ‘ambitious’ enacts ostracism and criticisms of ‘unwomanly drives for power’ or ‘family deprivation’ (Keller, 1985). When women act according to feminine standards, their traits are deemed inferior to men and when they act according to masculine standards, they are ostracised for their failure as a woman. Within this system gender acts as a regulatory function (Butler, 1990; 1999). It is the consequence of power structures, institutions, cultural practices and discourses, all of which, construct and regulate its meaning.

Hence, acting according to one's gender is seen as shielding a person from duress caused by societal backlash; in other words, internalization of societal values for the sake of cultural survival (Blackburn, 2005). An example of this, would be women using speech qualifiers, such as 'I think' or 'maybe' that make them appear less assertive when making a truth statement (Carli, 1989). This action makes women appear less knowledgeable or 'sure' of themselves, but its absence causes women to be perceived as mean, 'a bitch' or not leadership material.

Despite the fact that using qualifiers degrades the perception of their competence, completing these actions protects women from being called names, experiencing social exclusion and being passed up on promotions for their lack of social competency or likeability (Miles & Xi, 1999). As such, internalizing and performing the gender specific actions like using qualifiers protects women but hinders their ability to fulfill masculine leadership roles that favour assertiveness.

Connell (1995; 2012) suggests that this survival goes beyond just masculine and feminine, but into multiple masculinities and femininities. Within the dominant binary theory, the presumed biological cause of gender and the definition of non-adherence as pathology creates a system of hierarchies within each gender. Men who adhere to traits and actions intended to maintain their superiority are celebrated. Those who practice femininity or a combination of the two, receive societal backlash. Therefore, gender regulation organizes the hierarchical societal positions ascribed to each gender, and to the various levels of gender expression within each category.

Connell (1995; 2012) describes men who seek to maintain masculine superiority and the patriarchal system as aiding in the formation of a masculine hegemony. Women who look to accommodate the interests and desires of men, seek to maintain gender differentiations and

category adherence are said to be engaging in emphasized femininity or feminine hegemony (Connell & Messerschmidt, 2005). Both feminine and masculine hegemony “embodies the currently accepted answer to the problem of the legitimacy of patriarchy- which guarantees (or is taken to guarantee) the dominant position of men and the subordination of women” (Connell, 1995, p. 77).

It is theorized that hegemony is maintained within a society through the use of culture. Although economic and cultural formations are fairly autonomous, elite groups can use material culture, media and sources of knowledge production to articulate ideals (Laclau, 1977; Chafetz, 2006). Specifically, these groups can *woo* the masses by presenting such ideals covertly and continuously so that they begin to alter the interpretation of people’s lives. These cultural messages are framed according to the interests of the oppressors. They mediate the ‘meaning making’ between personal experience and how people come to define and understand it.

2.2 The Construction of a Gendered Science

Science is among the most powerful forms of articulation in Western society. By definition it is a knowledge producing institution that defines and studies the behaviour, structure and systems of the natural world (Ma, 2012). Science will be defined as the following disciplines within this paper: physics, chemistry, astronomy, biology, medicine, environmental science, mathematics, engineering and computer science. In general science is typically used to understand the natural world, and create much of the *man*-made world. In short, science defines the majority of ‘taken for granted’ knowledge affecting the daily lives and activities of billions of people (Cozzens & Woodhouse, 1995).

Due to the role of science as the producer of authoritative and trusted knowledge, it is considered a substantial agent of power. As a result, science has consequences for the present

and future human condition (Cockburn 1985; Wajcman, 1991). It defines what the human condition is, what problems exist within it, how to measure it and what to do about it.

As previously noted, articulation is the ability for elites to define the ‘problem’ facing society and have the means to smooth over contradictions to their ideology (Slack, 1996). Countless theorists have highlighted the unequivocal power of science to re-write the beliefs and understandings of people, surrounding an issue (Wajcman, 1991). Thus, to be in control of this power is highly desired as it allows individuals to be involved in controlling the present and directing and defining the future (Wajcman, 1991).

Universal science. The ability of science to control and articulate the beliefs and actions of an entire culture is contingent on its ability to dictate a single world view. Thus, the views of the many must be amalgamated into a single controllable perspective. This is achieved through a science culture called universal science. Universal science presumes that one perspective can stand for and judge all others, as a universal reference point (Bleier, 1984). In other words, the experiences of scientists and often those funding them, are used to form normative judgements on all other classes of people.

Universal science maintains this control through a regulatory system similar to that of gender. However, instead of masculine and feminine it uses objectivity and subjectivity, recall that these terms fall under the gendered dichotomies in Table 1. Additionally, instead of threatening mismatched identities with labels of pathology, universal science uses labels of illegitimacy. For example, in order for a theory to be claimed scientific, it must adhere to industry standards of objectivity and be accepted by the scientific community. This in short, means adhering to masculine standards and performance expectations, in order to avoid societal backlash in the form of rejected legitimacy of one’s work.

In order to investigate this further the relationship between universal science and masculinity must be reviewed in greater detail. Universal science defines ‘science’ as objective or free from emotion; and other relations to personal knowledge, experience, beliefs or values (Aikenhead, 2001; 2006a). It also states that scientific findings must be based on empiricism, replicability and be accepted by the scientific community (Kuhn, 1962; Aikenhead, 2001; 2006a). The concept of objectivity and the regulation and participation of the science community, are tied to historically masculine practices.

Objectivity was first used to differentiate masculine or legitimate knowledge from feminine or illegitimate knowledge. Specifically, scientific knowledge was obtained through specialized training in the form of a masculine mentoring relationship (Keller, 1985). According to Plato, objectivity or truth could only be achieved through the act of transcendence or the coming together of two or more rational masculine minds (*Republic*, 212a). By undergoing this process, boys were mentored into public positions of authority.

Accordingly, a hierarchical system akin to that of Connell’s multiple femininities and masculinities was formed around the legitimization of knowledge. Historically, lower class or enslaved men and all women were not allowed or afforded the opportunity to take part in mentoring practices, thus, their knowledge was classified as illegitimate. Feminine knowledge and perspectives were also classified as subjective, emotional and hormonally driven and thus, were devalued further due to the assumed partisan relation (Keller, 1985). Meanwhile, because objectivity by definition is knowledge detached from individual perspectives or in other terms ‘universal,’ masculine and ruling class perspectives were hidden under the guise of gender neutral and value free knowledge (Keller, 1985).

Thus, masculine perspectives parading as universal perspectives were used to define science, women and society. By virtue of being creators, researchers and observers, scientists have the power to control what and how entities, such as women, are defined and understood (Gordin & Gingras, 2000). Women have traditionally occupied the role of patient, subject, user of research, or a ‘subunit’ being controlled (MacCormack & Strathern, 1980). This has meant that the reality of women has been constructed in a large way by men, who regularly define scientific meaning in ways that oppress them.

This created a patriarchal system that reinforced gender binaries and embedded such binaries into scientific and Western culture. This elevates masculine traits such as rationality over emotionality, worldliness over personal experiences and instrumentality over nurturance (Table 1). The masculinization of the universal perspective also puts into play ideas of masculine dominance (Fox, 2006). It colours the disciplines and theories themselves. It is not simply an exclusion of women, but “a schism between masculine and feminine, subjective and objective, understanding and control” (Keller, 1985, p.27).

These patriarchal ideals have been maintained through the regulation of science by the scientific community. Men make up the majority of members within most scientific communities. As such, they act as gatekeepers to the participation of women in science. According to Kuhn (1962), acceptance and support in terms of choosing the ‘best theory’ is dependent on consensus of the scientific community. This means that factors including *fit* with current theories, theorists and cultural practices; can dictate the acceptance and denial of a theory and the scientists that create it. The work of women has suffered rejection from the community in disproportionate numbers.

Every piece of science must be accepted by peers to be deemed legitimate and women are severely disadvantaged in this process. They are less likely to be accepted into academia because the qualities and traits of a good scientists are built on masculine standards (Correll, 2001; Trix & Psenke, 2003); they are less likely to be published because their use of language skills differ from masculine peers (Budden et al., 2008; Hill, Corbett, & Rose, 2010); they are less likely to be nominated for awards because social networks tend to be gendered (Richman, Morahan, Cohen, & McDade, 2001) and women are outnumbered (NSERC, 2010). Finally, women fail to progress in nearly every peer reviewed process for no other reason than the gender on their application (Wennerås & Wold, 1997; Ceci & Williams, 2011).

The scientific system adheres to a masculine culture or ‘way of being’ that requires the embodiment of these ideals, in order to recognize knowledge makers as legitimate. Science maintains this patriarchal systems through societal forms of punishment. For example, people who fail to uphold masculine culture experience slowed career progression, intentional or unconscious acts of exclusion and subtle or overt ostracism (Gappa, Austin, & Trice 2007; Hewlett et al., 2008). Women that fail to uphold this culture can experience objectification and sexual harassment (Furtelli, 1999). They also experience silencing both in terms of publication and opportunity to appear publically (Mackin, 2015).⁴

Research has found that women tend to respond to this problem using two different tactics. The first is that they ascribe to Butlers (1990) theory of gender regulation and perform masculinity as a protective act. Accordingly, women look to take on masculine practices and limit their use of feminine symbols, writing styles, colours, knowledge bases and even clothing;

⁴ This is an evaluation technical report of the Promotion Science and Engineering program at the Natural Sciences and Engineering Research Council of Canada. It included a review of literature and primary data sources from Canadian women in science roles. They spoke promotion to youth, about barriers to women in prize competitions and in science in general.

in an attempt to succeed in anti-feminine environments (Hewlett et al., 2008). In some disciplines, the masculinization of the science role leads to a token-system. In these cases, women limit each other's participation, to increase their likelihood of being the single obligatory woman used to 'check the equity box' (Hewlett et al., 2008). This reinforces science as gendered and transfers the masculine meaning through media, material culture, academic instruction and informal science activities.

The second way women deal with this problem is by leaving science altogether. They migrate to other highly skilled labour forces that will recognize their knowledge as legitimate without forcing them to give up their femininity (Hewlett et al., 2008; NSERC, 2010; Canadian Council of Academies, 2014). This creates a greater divide in terms of representation that widens at every career juncture. Consequently, the highest science ranks are almost entirely devoid of feminine participation (Canadian Council of Academies, 2014).

Both of these tactics uphold the science hierarchy and maintain a hegemonically masculine culture. As science is a part of the education system this hegemony, is transferred to younger generations through the propagation of educational materials produced almost entirely by men (Peller, 2001). This has grave repercussions for the reproduction of science culture, as this culture is being expressed to younger generations in a masculine form (Peller, 2001).

2.3 Promoting Science to Youth

The transfer of masculine science to younger generations occurs through several cultural outlets. This paper argues, that informal science plays a large role in this process and is a major proponent in the articulation of science ideals to children. Specially, I argue that masculine scientific meanings are transferred through gendered symbols embedded within science content. That these symbols redefine science as gendered, creating a lack of fit to the interests of girls,

and hostile atmosphere for feminine pursuit. This creates a self-sustaining cycle where underrepresentation of women reinforces masculine culture and content, which further exasperates the problem of fit, leading to future underrepresentation. In order to investigate this further, the role of informal science in science interest will need to be explored.

Informal science learning (ISL), is a set of entertaining, hands-on or interactive science activities that are usually self-directed and is based on free choice or interest (Mackin, 2015). Science toys, kits and media are a subset of informal science. ISL is the most commonly used tool by governments, schools and families to promote science interest to children (American Society for Engineering Education, 2011; Canadian Association of Science Centres, 2011; NSERC, 2015). The natural science foundation (1992) described informal science as one of the three foundational pillars of science education, along with primary and secondary schooling. Around 60% of North American youth have participated or taken up ISL media in the last six months (Lloyd et al., 2012). Furthermore, research on science toys and kits within library systems, found that 75% of the time, all of the kits were checked out and children were waitlisted (CAISE, 2010a).

In terms of impact, toys and science kits were identified by scientists as the third most influential medium for garnering their early interest (NSERC, 2015a). In general, informal science has been credited with sparking interest in many youth and changing career trajectories of teens, whom fall in love with science through these activities (CAISE, 2010a). Finally, informal science has been used as a tool to dispel stereotypes about scientists and science disciplines as not ‘fitting.’ This has led to an increase in representation and student interest in nearly every demographic, except girls (Kelly, 2008).

The following section will look into the barriers that still exist for girls within the realm of informal science. It will also investigate the way gender symbolism mediates the continued problem of fit for girls within these contexts. To begin, a symbol is something that stands for or conveys another meaning (Marshall & Scott, 2009). In this case, gender symbols would be an image, text, shape, size of equipment or other symbols that indicates the appropriateness of science to either masculine or feminine gender schemas. There are many symbols involved in the transfer of gendered meaning within informal science, this section will cover the three most relevant.

Scientists are depicted as white men. The severe underrepresentation of women in visible scientific roles, along with their decreased participation in the creation of science content, has created a masculine scientist archetype. The stereotype of the lonely eccentric white-male scientist is most commonly portrayed in media and classroom texts (Nisbet, 2002). This image portrays science as an indoor activity that is isolating, unadventurous and linked to those who are socially awkward and ‘uncool’ (European Schoolnet, 2011). This lies in opposition to many stereotypically feminine values that prize social prowl, co-operation and knowledge production for altruistic or community welfare reasons (Blakemore & Centres, 2005; Harrison, 2009).

The masculine scientist archetype also provides the same set of demographics in each instance, which isolates girls who are not represented as possible scientists. This is especially the case for girls who are visible minorities, students with disabilities and other demographics who fail to fit this image on several levels (Rockman et al., 1996; Alston & Hampton, 2000). It has long been recited that ‘you can’t be what you can’t see.’ Nearly 50 years of draw-a-scientist studies confirm this (Finson, 2002). Despite drawing themselves as science students, girls rarely depict women as scientists and describe the adult science role as ‘for men.’

The absence of feminine scientists in girls' drawings is evidence of the symbolic annihilation⁵ of women within the scientist role. This will be discussed in greater detail in subsequent sections, but in short, it means women are simply not depicted or valued as potential scientists. The opposite effect occurs with exposure to programs and content that seek to provide feminine mentors and feminine representations (European Science Education Initiative, 2004c; Harrison, 2009). This leads to the re-emergence of feminine scientists in these drawings (Finson, 2002). Girls are also more likely to present a woman scientist which is a stark contrast to the nearly uniform portrayal of masculine scientists by all children prior to such exposure.

Use of masculine knowledge bases. Boys and girls have different knowledge bases. Gendered play and more specifically playing with gendered toys develops different skill sets in boys and girls. Toys designed for boys tend to include science precursors such as the development of rotational symmetry (Francais, 2010), building, tool and equipment manipulation, proprioception as well as trial and error or exploratory learning (Auster & Mansbach, 2012). Toys intended for girls often focus on esthetics, social interaction, nurturance and domestics (Auster & Mansbach, 2012). Consequently, science related skills possessed by girls tend to be related to reading, identifying subtle differences in visual stimuli and tactics for obtaining knowledge like memorization (Salmi, 2007; NSERC, 2010).

As science activities tend to be catered to a masculine ideal, ISL tends to design activities that match masculine knowledge bases. This causes girls to feel negatively about their abilities and about science (Salmi, 2007; Bell, Lewenstein, Shouse & Feder, 2009; NSERC, 2010). It also

⁵ This is a term used in the social sciences to depict the disappearance of women from media in roles related to out-of-home employment, and leadership positions. It highlights the connection between the disappearance of women in media in regard to roles that do not cater to masculine ideals (i.e. not sex objects, wives, mothers etc.) as a sign of their oppression in the greater culture (Klein & Shiffman, 2009). It does not suggest that this trend depicts realistically the representation of women in real-life roles. In fact, the purpose of this term is to showcase the unrealistic portrayal of women as a form of articulation that perpetuates their oppression.

makes others (teachers, parents, peers) doubt their competency and their fit with science tasks and creates an atmosphere of ongoing subtle discouragement (Lewenstein, Shouse & Feder, 2009). These sentiments occur even when girls have higher science achievement scores than boys. This trend of low confidence among girls and their social supports reverses when longer term activities are provided and skillsets held by girls are considered (Salmi, 2007; European Science Education Initiative, 2004).

Activities are inauthentic for girls. Authentic activities are a subset of ISL that focus on making connections to the lived experiences, beliefs and values of youth; as well as practical applications for science. It is one of the most celebrated tactics for developing youth science interest because it helps children learn abstract theory and allows them to apply those lessons in their personal life (Yair, 2000). This fosters self-driven investigation that helps create sustained personal interest. It can also dispel myths about the nature of science work as ‘isolating,’ ‘for boys’ and increases the breadth of careers that students attribute to the discipline (Harrison, 2009; American Society for Engineering Education, 2011).

Research shows that this tactic both has the most promise for increasing interest among girls and can be the most detrimental to girls interest if ignored. When content includes feminine themes, value systems, characters and knowledge bases girls become substantially more engaged and developed positive feelings towards science (Baker & Leary, 1995). Additionally, studies show that content that is authentic-to-someone-else has alienating effects that can create negative feelings in excluded groups (Mason & McCarthy, 2006).

While science toys have yet to be investigated in terms of science imagery, the presence of masculine symbols in other forms of ISL do not paint an encouraging picture. Many museum exhibits were described as having masculine content, which has been found to lower interest of

girls (Crowley, Callanan, Tenenbaum, & Allen, 2001b). Likewise, science camps, interactive media, science websites and science television shows tended to cater to masculine audiences (NSERC, 2015). Finally, Diekman & Murnen (2004) found that ‘gender neutral’ science content tended to display masculine colours and imagery.

The authenticity of an activity mediates not only the feeling of fit for the child, but the perception of fit for many gate keeping groups. Rockman et al. (1996) found that parents felt science media, toys and books were ‘for boys.’ They were also less likely to purchase toys, hobby materials and science media for girls (Bleeker & Jacobs, 2004). In many cases, parents, teachers and peers engaged in surveillance and discouragement of the participation of girls in science activities when masculine content was present (Bleeker & Jacobs, 2004). Parents also provided simpler explanations and spent less time explaining science content to girls (Bell et al., 2009).

Symbolism plays a large role in these interactions. The presence of symbols have been found to trigger pre-established understandings of gender appropriateness. Within science media the negative outcomes related to the problem of fit, disappear when feminine symbols are presented on the media (Bell et al., 2009). In fact, some studies have found that the trend reverses (Bell et al., 2009; CAISE, 2010b).

2.4 Developing Science Interest

The absence of women in science influences the way informal science is portrayed to children. It affects who makes science content and what symbols, themes, colours and characters are used within it (Hewlett et al., 2008). It also affects the demographics of role models running science activities (Hanes, 2006). This subtly conveys who science is for and who scientists are. (Goodyear, 2006).

In general, this has led to an absence of gendered role-models, a lack of catered content and in-authentic themes. Each of which, present a series of symbols that affect the formation of youth science interest. This is important as a mismatch gender role identity can impede the uptake of valued activities (Holmes, 2003). Furthermore, gender symbolism within activities convey potential ‘fit’ to the identity of a child. In order to understand the relationship between fit, identity and science interest; science interest must be discussed in greater depth.

In general, the goal of science promotion and informal science is to form a sustained personal interest in science among children. This type of interest has been found to predict science uptake later in life (Harrison, 2009). A sustained personal interest is defined as long standing interests that are internalized and self-driven (Hidi & Renninger, 2006). They are often related to an activity or interest based identity, where the person categorizes themselves as an enthusiast.

A sustained personal interest is created in three steps and symbolism plays a key part in each. In order to attract a child to an activity or spark situational interest, the content has to be perceived as fun, or relate to themes that relate to a child’s pre-established preferences (Pedretti, 2003). Situational interest is a short lived interest that is situation specific and related to stimuli in the immediate environment (Hidi & Renninger, 2006). Due to the time constraints, an activity has to be authentic or appear to fit, at first glance (Bell et al., 2009). It also has to be fun, which means it appeals to the child’s preferred modes of play, which are usually related to gendered toys.

The themes and modes of play including size of equipment in the vast majority of ISL activities have been found to cater to a masculine audience (Crowley, Callanan, Tenenbaum, & Allen, 2001b). Studies of museum exhibits, science camps and other ISL programming have

continually highlighted the reluctance of girls to join or become involved with a task when it is first presented (Salmi, 2007).

Situational interests can transform into a personal interest or interests based on internal drives and preferences that relate to beliefs, attitudes, past experiences and values (Hidi & Renninger, 2006). To do so, it needs emotional engagement or the formation of positive emotions relating to the activity and linking it to their lives (Hidi & Renninger, 2006). This is done through authentic tasks and by avoiding negative emotions, such as those created by requiring a skill set one does not possess.

The key to this level of interest is the avoidance of negative feelings that would derail involvement or personal connection to the content. Currently, ISL content has been found to cater to masculine skillsets, which make girls feel negatively about their ability (Salmi, 2007). Also, the presentation of masculine mentors has been found to trigger a mismatched identity, which leads either the girl to move forward and experience backlash from peers, parents and teachers, or give up their interests (NSEC, 2015b).

Finally, a personal interest can be transformed into a sustained personal interest. Sustained personal interests are characterised by positive feelings, stored knowledge and established values or themes relating to pre-existing personal interests (Hidi & Renninger, 2006). Once formed, well developed or sustained personal interests take priority over other emerging interests as they are regularly a part of the identity of the person (Hidi & Renninger, 2006).

One of the most influential ways to create a sustained personal interest is through community support and shared interest. By creating a community of peers, these activities help children to form a shared identity. This reinforces an individual identity as a scientist and affords a social outlet for the exchange of knowledge and passion (Harrison, 2009). Matched

demographic mentors are especially important for girls, as they create a sense of identity for students who otherwise see science as ‘not for them’ (Dorsen, Carlson, & Goodyear, 2006).

As was previously suggested, the presence of masculine symbols, themes and knowledge bases in science content tends to absolve these social supports. Hewlett et al. (2008) found that engineering culture was anti-feminine and feminine mentors adopted and communicated this mentality. This ‘handed down’ a culture that was alienating to younger generations. Likewise, peer groups tended to pull girls away from these activities to socialize instead of engage. As such, interested girls were pulled away from participation and consequently negatively affected (Rockman et al., 1996). Parents and teachers were also likely to discourage girls, most often through assuming a lack of competence, which again was mediated by the presence of masculine symbols.

Thus, gendered symbols have been found to play a role in establishing or negating each level of interest formation. According to the theory of possible selves, the perception of science as masculine, when paired with an absence of role models, symbolic representation or encouragement, conveys science as something that girls don’t do (Dorsen, Carlson, & Goodyear, 2006). Thus, as suggested by the Colman report (1966) a science identity is a part of a social negotiation, where the child must feel like they fit with the discipline and those within it. This is clearly not the case for either girls or women in the science realm.

There is overwhelming evidence that science and informal science is thought of as masculine to youth, adults and in the greater society. There is no research to date on science toys and very little research on science symbols on gendered toys. Therefore, the role of this medium in the transference of masculine science culture is unknown. Unlike other forms of ISL, toys are used specifically to socialize gendered understandings of societal appropriateness (Leaper &

Friedman, 2007). They are used to teach gendered work and encourage labour specific skills for education and employment (Leaper & Friedman, 2007). They are also symbolic of relational support, due to the fact that toys are a gift from parent to child, imparting emotional meaning (Baxter, 2005). Thus, the symbolism provided through this avenue has the capacity to be much more influential than other areas.

2.5 Gender Symbolism in Promotional Content

In order to understand how symbols are conveying meaning more information regarding the role of symbols in portraying a sense of 'fit' is required. To begin, symbols are acts, sounds or objects that have cultural significance and the capability to enact a response from the person perceiving it (Baxter, 2005). Basically, symbols are something that stands for or conveys another meaning. This is done by association or the construction of a relationship in symbolic form. Most often symbols are used to denote something abstract or something that cannot or is not socially acceptable to say outwardly (Baxter, 2005).

Material culture such as toys, convey meaning through the presence of symbols. Through these symbols material culture represents the social relations of a society and symbolizes its values, ideas and emotions (Dart, 1999). This medium also plays an important role in providing avenues for accessing cultural beliefs that do not appear in verbal culture. This occurs when cultural assumptions are so basic and interwoven into societal values that they are rarely verbalized, or when social conventions are built on meanings too emotionally laden for direct discussion (Calvert 1992a, p. 4). This includes the common use of oppressive beliefs that are no longer socially acceptable to verbalize outwardly, but still underpin major practices within a society (Dart, 1999).

It is argued that the beliefs and even the oppressions imparted through material culture have a co-constructive cycle where material culture informs social beliefs and beliefs form material culture. Thus, the social and material worlds are not considered separate structures (Bourdieu, 1977; Miller, 1987; Schiffer, 1999). The exchange of social knowledge between these two mediums is most prominent in childhood when toys are used to socialize children into social beings. Thus, toys are an important medium for gauging the transference of oppressive ideologies within a culture.

The majority of merchandise intended for children uses colour coding and gender symbolism to signify the gender appropriateness of their products (Grohmann 2009; 2014). These symbols draw on cultural defined ideals surrounding each gender, recreating the binary gender concepts in visual format. The socialization of these gendered meanings and values and their internalization occur in the first years of youth. The goals a girl should invest in, the traits that are deemed desirable and the work that ‘fits’ these feminine themes, are all concepts emphasised through the use of toys (Martin & Halverson, 1981).

According to Butler (1990), the dominate gender binary is created through “stylized repetition of actions through time” (p.7). In other words, the repetition of messages received and repetition of appropriate responses. These triggered responses become such second nature they are in fact believed to be nature its self. Through their recurring enactment over time and space, these symbols and their associated practices structure the production and distribution of resources in the greater society. As well as, the distribution of power in the form of scientific authority (Bourdieu, 1990). This authority is described by Connell (2000), as cultural symbolism or the production of meaning and values.

Research on parent-child interactions and gendered toys show how cultural symbols are used by adults. Specifically, these symbols are used as categorical cues to reinforce gender concepts and teach stereotypical responses (Oakhill, Garnham, & Reynolds, 2005; Leaper & Friedman, 2007). In other words, parents use the emotional connection between a girl and her toy in combination with disciplinary actions for choosing the wrong toy, to create emotional avoidance of masculinity and uptake of femininity (Liben & Bigler, 2002). Again, gender becomes a performance that shields a child from the duress of gendered regulation. When repeated enough times, these subtle teachings begin to solidify a sense of ‘belonging’ to the hegemonic feminine category (Grusec & Hastings, 2007).

Gender symbols are an important part of this process as they are used to signify what is and isn’t appropriate for the feminine category (Frassanito & Pettorini, 2008). Bargh (1999) found that these symbols were internalized by youth and formed deep rooted biases, values and preferences for activities and actions. These stereotypes were so engrained that the act of viewing a gendered symbol, often lead to an automatic stereotypical response (Bargh, 2006). This is important as articulation in hegemonic theory states that the redefining of the beliefs and values of an individual, to match ruling class ideology is based specifically on the ability of repeated cultural messages to elicit desired responses (Laclau, 1977; Slack, 1996).

This symbol-behaviour connection is established by the age of six. At this time girls form a schema of stereotypical values, actions and activities appropriate for their gender (Martin & Halverson, 1981; Bem, 1987; Meece, Glienke & Burg, 2006). Activities related to science are regularly identified as not fitting this schema (Mackin, 2015). Other researchers found that in general, girls perceive content with science symbols as ‘for boys’ (Baker & Leary, 1995; Prokop, Prokop, & Tunnicliffe, 2007).

Research on demographic representation in toys have shown that continually providing characters in valued positions that do not represent the demographic of the child has detrimental effects (Clarke & Clarke, 1950). Specifically, mismatching symbols can lead to an 'othering' identity, where children see themselves as devalued for not being or possessing the qualities on the toys (Powell-Hopson & Hopson, 1988; Holmes, 2003). This othering identity results in underrepresented groups losing confidence in their abilities and feeling vulnerable for pursuing related activities.

Now that the relationship between symbolism, toys and science has been explored, the symbols themselves must be discussed. As gender symbols in science and within toys rely on pre-established standards in uncovering gendered meaning in advertisements, these foundational concepts will be discussed prior to gendered science trends. Due to the overlap in the next two sections, only evidence of the foundational theories will be discussed in the subsequent section.

Gender symbols in advertisements. The images used in advertisements have become so complex and convincing in modern times that they are now capable of organizing our understandings of the world in a meaningful way (Kang, 1997). The ability for an advertisement to redefine or propagate meaning is based on the assumption of shared culture. Hall (1997) proposes that members of the same culture must share a set of meanings, symbols and ideas in order to allow them to interpret the world in the same way.

Jhally (1987) argues that advertisements are mediators. In order for the audience to 'decode' a message, advertisers must create and represent meanings that are already within their social knowledge base. Advertisers 'encode' information using these familiar symbols and meanings and transform such meanings into messages that sell their products. In many cases, this includes creating anxiety around the ability of a person to fulfill a desired role or trait by

portraying impossible standards and then positioning the product as a remedy or quick fix (Frank, 2000). These standards tend to be gender specific as roles and traits are divided by gender within Western society. These meanings are rarely portrayed overtly, as patriarchal ideals surrounding feminine roles would be flagged as sexist if they were displayed prominently (Slack, 1996).

The majority of images in present-day advertising use several multi-leveled meanings. They create both overt symbols, immediately recognized by viewers and hidden or covert meanings that are taken up unconsciously (Goffman, 1979; Belknap & Leonard, 1991). Covert symbolism has included messages used to frame societal problems in a way that maintains patriarchal ideals (Slack, 1996). For example, women are commonly portrayed as weak, childish, dependent, domestic or irrational; their short-comings are framed as ‘the problem’ within the advertisement scenario.

Men, and by association products to attract men, are then positioned as the answer (Komiser, 1977). In such cases, gender differences including societal status, were not only transferred from the real world to the advertising world, but according to Goffman are “portrayed in their purest expression” in such mediums (in Kang, 1997, p.983). The current section reviews research surrounding gender symbolism and women’s status within advertisements. This includes the expression of power relations, appropriateness of and competence in completing a task, the purpose of one’s role, as well as gendered stereotypes.

Goffman (1979; 1981) posed that the subordinate roles held by women were often conveyed by their relationship to another character in the photo. This was done by eliciting pre-existing understandings of stereotypical relations between men and women. It also appeared in the provision of a physical comparison between characters. He classified specific instances of

these subordinations into the following categories: function ranking, the family, relative size, licenced withdrawal and the ritualization of subordination.

Function ranking. When both a man and woman are involved in a shared activity, function ranking is the visible presence of the man as the executor of the task and the woman as a support role (Belknap & Leonard, 1991). For example, the man fixing a car and the woman holding the wrench. This portrays the man as the person in charge of decision making, the active agent and the person holding the expert knowledge for the task. Although this executor-assistant relation is most common, there is an exception to this rule. When the task is stereotypically feminine the man in the photo is portrayed as uninvolved in the task and the woman is not pictured in an expert role (Bell & Milic, 2002). For example, she is a cook not a chef.

The family. The term family was used to signify the gendered bonds between mother and daughter and father and son. Goffman (1979; 1981) posited that mother-daughter relationships were depicted as more intimate and emotionally charged, hugging for example. Father-son relationships were presented as more spatially distant and focused on instrumentality. The parenting role for women was traditionally depicted as supplying nurturance and love; and the lesson directed towards girls was emotionality. Similarly, the role of men was to impart knowledge and toughness; whereas the role of a boy was to skill build and distance himself from emotion.

These concepts map-on to historical understandings of science and gender. The concept of ‘distance’ aligns with objectivity that is the distancing of a scientists work from their emotions and personal experiences. The imparting of knowledge through a masculine mentorship also aligns with objectivity, which was originally only obtained through this practice. Finally, the

focus of skill building and distance from emotion relates to ‘rationality,’ which is constructed as the opposite of emotionality and a trained skill.

In contrast, women and girls relations map on to subjectivity through the personal or relational experience illustrated by the focus on relationships with love ones. The mother daughter relationship also included emotionality and the private realm where nurturance takes place. This familiar relationship, which is common in advertisements, reinforces both stereotypical roles and lack of fit to scientific culture.

Relative size. Goffman (1979; 1981) and many other theorists have highlighted the use of size as an advertising tactic for showing domination. Larger characters are presumed more dominant and smaller characters less dominant. Consequently, women were depicted as shorter in stature, either physically or because they are standing in the background of the photo (Bell & Milic, 2002). Men commonly occupied the foreground, were larger or centred in the camera angle. Basically, these tactics were used to symbolize that the scene was about ‘him’ and that the presence of the woman was to support or progress the story of the man.

Licensed withdrawal. Goffman (1979; 1981) theorized that when women were depicted in advertisements they were given the opportunity to withdraw from the scene around them, symbolically, because they were ‘under the care’ of a masculine protector. This protective presence allowed women and girls to ‘tune out’ the surrounding environment (Belknap & Leonard, 1991). This withdrawal was often symbolized by a de-attached gaze. For example, looking off into the distance or appearing preoccupied. Other forms of withdrawal included hiding or standing behind objects, covering ones face to conceal an emotional reaction, being removed from the activity at hand despite being signaled as part of it (Kang, 1997). For example,

a woman being on a sports team but not depicted in the sports activity. Such withdrawals did not happen when women were alone or with other women.

The ritualization of subordination. This refers to the tendency for women to be presented in inferior positions and poses in relation to masculine characters (Bell & Milic, 2002). In general, women were more likely to be found in spatially lower positions, for example, women sitting and men standing. Women were also more likely to be engaging in appeasement, or submissive gestures toward masculine characters (Kang, 1997). This included body or head canting,⁶ looking up at men obediently, listening and affirming poses-in regard to men's action and showing sexual availability. There was also a tendency to show women and girls as 'under the protection' of a man (Bell & Milic, 2002). For example grasping a man's arm, having their hand held in a leading gesture, or having their shoulders held.

Ritualization of subordination also relates to a large body of work on the *male gaze* and *relational dependence* and has many overlapping themes. In general, when a woman is in a photo by herself, her status is often defined by her relation to the camera, which is presumed to be masculine in other words the 'male gaze' (Bell & Milic, 2002). Similar to the appeasement gestures that occur when a man is present in the scene, women have been found to appease or *romance the camera*.

Romancing the camera. When women and girls romance the camera, they are portraying a relationship to the masculine viewer. Although, the most common relationship depicted is sexual, this technique can also display familiar relationships and plutonic ones. A common familiar relationship is the 'down shot' or 'birds eye view' where the camera is looking down on

⁶ Body canting is tilting body parts in a suggestive manner, toward a designated usually masculine audience, which would convey attraction or affection.

women or little girls (Bush & Furnham, 2013). This portrays the camera as an authoritarian role over the character, indicating that the woman and girls have a lower status than the viewer.

When romancing the camera is used sexually, women are portrayed as making themselves sexual available or appealing to the viewer. This has also been described as objectification, body display and sexual availability within the literature (Kang, 1997). A common pose used to convey this message is the 'reclining nude'. This body posture was named from a common artistic pose where women were often found to be in reclining position, with their body naked and fully observable and the models gaze looking away (Crawford, 1997). This averted gaze was described by Kress and van Leeuwen (1996) as signalling sexual availability, as the audience becomes the 'invisible onlooker' or 'peeping tom' and the woman becomes an object for viewing pleasure like a "specimen in a display case" (p.124).

A second common pose within this category is the 'come and get me'. Women are often depicted with revealing or tight clothing, looking at the camera with another gesture intended to invite the viewer into sexual viewing (Kang, 1997). This may include the character placing their arms over their head accentuating the breasts or providing access or availability to their body. It may also include biting the lip, sexual pouts, arching the back and other common symbols of sexualisation (Gill, 2008).

According to Kress and van Leeuwen (1996), the characters gaze and gesture demands something from the viewer, it creates an imaginary relationship between the audience and the character. When accompanied by sexual symbols it demands that the character be desired and by virtue of defining desire, it also defines the audience. In defining the audience as masculine and women as an object for their appeasement; it defines women both as a non-targeted audience and as a relational entity that gains meaning through masculine desire.

Relational roles. Within advertisements, meaning about women is often defined by the relational roles to children, men or a masculine viewing audience. Research into this form of symbolism has been called a measure of independence (Kang, 1997) and the good woman (Ortner, 1981; Sjoberg, 2006). Essentially, the roles typically attributed to women include relational roles such as mother, daughter, wife, victim and sex object (Ortner, 1972; Sjoberg, 2006). When depicted in these roles women engaged with objects in a form of unspecialized work such as domestic duties (Gauntlett, 2004). They were also commonly portrayed in service to others by completing childcare, taking care of a sick parent or fulfilling sexual fantasies.

Research found that women rarely appeared in advertising within roles that were unattached or independent of other characters. In 83% of advertisements they were portrayed within the home or private realm (Courtney & Lockeretz, 1979). Conversely, men were almost exclusively portrayed outside of the home, engaging in either work related roles or leisure roles. In less than 10% of advertisements, women were portrayed in work related roles, the sheer absence of women in roles that relate to careers, authority, power, knowledge and decision making has been used to depict women lower social status in society.

Absence. This symbol was not a part of Goffman's original critique of gendered advertisements. It is however, an important symbol and thus was included into the list. The absence of women and other oppressed demographics within the media, has been named symbolic annihilation (Merskin, 1998; Klein & Shiffman, 2009). By definition it is "the way cultural production and media representations ignore, exclude, marginalize, or trivialize a particular group"(p. 35). This theory states that groups that are valued within a given culture are depicted more often than those that are not valued.

For example, Klein and Shiffman (2009) found that in children's cartoons women were present in 16% of scenes, were commonly sexualized, and were 6.5 times more likely to be above average in attractiveness. The representation of women in children's cartoons has not increased since the mid-1960's (Klein & Shiffman, 2009).

When groups are devalued they are absent or symbolically annihilated from media, or as is suggested above they are depicted in a relational role where they exist for the purpose of other characters. The dominance of relational roles can also mean that a group can also be symbolically annihilated from specific roles, including career roles and roles showing authority, power or competence. As suggested above women are noticeably absent from work related and public-realm roles within visual media (Gauntlett, 2004). Feminine scientists are one of the many symbolically annihilated career roles common to educational and mass media.

2.6 Gender Symbolism in Toys and Educational Media

As educational media is a form of promotion and toys are consumer products that are advertised, the trends within gender advertising also apply to scientific contexts. In particular, subtle and overt gender cues that reiterate the symbols of subordination, annihilation and lack of fit, appear. Among the gendered symbols, the following themes emerged: mentor demographics and feminine absence; gender of child on the package and relational roles of children when there are multiple; absence or presence of children on the package; gendered themes; and colour or shade of the promotional content.

Mentors. Research has found that nearly all scientists and mentors within science television were depicted as men (Steinke & Long, 1995; Rockman et al., 1996). Thus, scientific media, much like gendered media, portrays the symbolic annihilation of women in career oriented roles. Women were also depicted in trivialized roles. Occasionally, a show with a

prominent masculine scientist had a feminine scientist visit the show as a helper or demonstrator. In these instances, the masculine mentor took on the role of the expert, and the feminine scientists took on the role of assistant. These fleeting appearances make up the majority of representations for women scientists (Steinke & Long, 1995).

In one case a woman mentor was cast as the main character, but her role was still trivialized. This occurred in an animated television series in the 1980's called *Magic School Bus*, which had a feminine mentor (Steinke & Long, 1995). While a step forward in terms of representation, this mentor was a school teacher for young children rather than a scientist. This distinction maintained the absence of women in the role of scientist and still portrayed the traditional feminine role of caregiver or chaperone.

Much like the television show, research on educational toys, found that women were primarily depicted 'minding the children' and men were depicted in authoritative, teaching roles (Bush & Furnham, 2013). This also occurred in science themed books (McCabe, 2011). Research has also found that viewing stereotypical gender roles caused girls to downplay their science interests and ambitions (Geis, 1984).

Gender of children. When gender of children was used as a gender symbol a similar pattern of executor or expert was assigned to boys. In education and gendered toys, boys were portrayed as the dominant characters in both types of toy advertisements (Bush & Furnham, 2013). Educational toys had more masculine main characters than gendered toys. Research on books, activity guides and colouring materials for children have found not only an overrepresentation of masculine characters but a substantial absence of girls and women (McCabe, 2011). The magnitude of absence was so great it was labeled a symbolic annihilation of femininity within this domain. Moreover, both boys and girls were found to prefer stories

about boys and men. Authors also awarded writing prizes more often to books with masculine characters (McCabe, 2011).

Bush and Furnham (2013) also found that in both gendered and educational toys, girls were almost always supervised by a mentor. This plays into the idea of guarding and protecting girls. These girls play the 'pure' or 'vulnerable role' and therefore, require nurturance, encouragement and sheltering. Likewise, when girls were not under supervision they tended to appear in groups. Again, alluding to their need for protection. Science television shows, also depicted girls as in need of assistance (Steinke & Long, 1995). Girls regularly held the position of science assistant and were guided through each science experiment by a mentor.

Girls also appeared more often in student roles. When they appeared in these roles they were consistently portrayed in a more trivialized positions than masculine students (Steinke & Long, 1995). Furthermore, girls commonly asked questions, appeared confused or unsure. These portrayals of ignorance were used to advance the plot as it prompted the scientists to launch into a scientific explanation (Steinke & Long, 1995).

In contrast, masculine students were portrayed as experts who elaborated on information provided by the scientists or guided girls in science tasks (Steinke & Long, 1995). This conveyed boys as not requiring assistance and therefore, independent and knowledgeable. Similarly, in gendered and educational toys, boys were presented without mentors or surveillance more often than girls (Bush & Furnham, 2013). It was theorized that boys were alone to depict their independence and 'in control' nature.

It is worth noting that gender representation in educational media forms a bell shaped curve across time. It has low representation in the 1960s and 1970s and increased and in some

cases nearly equal representation in the 1980s and 1990s (Mccabe et al., 2011). It then declines again starting in the 2000s.

Absence or presence of a child. Research has found that in gendered toys, girls tend to be depicted on the packaging playing with the toy and boys tend to be absent from the packaging (Griffiths, 2001). Instead, toys intended for boys depicted the toy in action. It has been theorized that this difference is related to the belief that boys are more imaginative and can infer the relation between the photo and their adventures. In contrast, girls are believed to be less imaginative and require a visual connection (Griffiths, 2001). I suggest that this may be an active versus passive bias, where masculine toys are presented animated and in a ‘coming alive’ state, where toys designed for girls are presented as passive or ‘unalive’ state.

In one study, gender themes were present for masculine toys at all ages, but did not appear for feminine toys until after the age of ten (Berenbaum & Hines, 1992). No explanation was given for this trend. Perhaps, there was a switch in advertising trends from non-sexual to sexual advertising at this age. The absence of these stereotypes may relate to their absence of usefulness in delineating masculine ideals.

Gendered themes. Research on gender themes for gendered toys shows that toys intended for girls focus primarily on domestication and beauty. They included jewelry, cosmetics, dolls, cooking and cleaning equipment (Auster & Mansbach, 2012). Interestingly, one study found that 3-8 year old girls liked masculine and feminine themed toys equally (Berenbaum & Hines, 1992). Another study found that 3-5 year old girls prefer masculine toys to feminine toys (Idle, Wood, & Damarais, 1993). It also found that parents and boys found feminine toys less interesting, but that parents often preferred these toys for girls.

Toys directed towards boys included vehicles, weapons, building toys and action figures (Auster & Mansbach, 2012). These toys were almost unanimous in their manufacture label of ‘toys for boys.’ These toys focused on aggression, risk taking and skill building. There is considerably less data on the interest of boys in cross-gendered play. The information that does exist is based on colour of the toy. In this case boys were more likely to uphold stereotypical gendered choices than girls (Wong & Hines, 2015).

Parents were found to encourage boys to play with masculine toys more than feminine toys (Idle, Wood, & Demarais, 1993). Boys also felt that parents would be less accepting of their choice to play with a feminine toy if they wanted too (Freeman, 2007). In fact, only 9% of boys felt their father would be okay with cross-gender play, in comparison to 20% of girls. This trend increases with age (Freeman, 2007). This may suggest cultural ideals surrounding guarding masculinity may be socialized at an early age. Some research suggests that colour is used as an early socializing device to designate appropriate toys according to gender.

Colour and shade. Toys designed for boys have been found to have bold or dark colours in 90% of the cases and toys for girls had about 50% pastels and 50% bold colouring (Auster & Mansbach, 2012). Colours attributed to each gender vary by study. Red, black, grey and brown tended to be cited across many studies as masculine, blue and green were included as masculine in some studies, but not others (Auster & Mansbach, 2012; Wong & Hines, 2015). Feminine colours were uniform across studies and included pink and purple. Research on colour preferences reveal that girls prefer pink more than boys do, but that no other differences exist for blue or any other colour (Auster & Mansbach, 2012). This difference may again reflect the increased standards for adherence to gender practice among boys, due to harsher gender regulation.

When masculine themed toys were coloured pink boys were less likely to use them and when feminine themed toys were coloured blue boys were more likely to use them (Wong & Hines, 2015). Likewise, girls were more likely to play with masculine toys when they were coloured pink, but no difference occurred with blue feminine toys. Furthermore, mixing gendered colours with gendered themes created both a larger range of likes and dislikes within each gender category; and more agreement between categories (Wong & Hines, 2015). This suggests that the symbols, *not the toy*, maybe dictating toy choice.

Given this information, the current study looks to study gender symbolism in science toys. It seeks to determine if science symbols are being portrayed in a gendered way. Specifically, it looks to investigate the following propositions:

P₁: Presence or absence of characters on toy packaging as a gendered symbol

P₂: The shade of a toy will be predominantly dark (matching masculine toys)

P₃: Girls will be absent from photographs more often than boys

P₄: Boys will be presented more prominently in photographs

P₅: Boys will be doing science more often than girls

P₆: There will be an absence of women mentors on packaging

Chapter 3: Methods

For the current study, a directed content analysis was used to assess gendered symbolism in science toys. Content analysis is a systematic method for identifying and analyzing special characters within an image or text (Holsti, 1968). Directed or deductive content analysis (DCA) is one that starts its inquiry with a theme or hypothesis (Hsieh & Shannon, 2005). The theme or overarching question directing this research is ‘Do science toys include overt and subtle visual symbols that convey science as masculine?’ Generally, DCA is used to ‘fill in the gaps’ in pre-existing research. It does this by either exploring new contexts in which the theme appears, or uncovering the relationship it has to new themes or group of themes (Humble, 2009). This method was appropriate because there is ample research on the gendering of visual symbols in toys and science books but not in science toys. The following study looks to explore the generalizability of these findings in relation to science toys and informal science tools for children.

3.1 Methodological Perspective

According to Hankammer and Hankammer (2006) the assumptions applied to the design process, analysis and interpretation of data, is greatly affected by the beliefs of the researcher about knowledge and inquiry. The following section looks to explain the ontological underpinnings of the research project. These include a liberal feminist perspective and a critical realist perspective.

To begin, feminism is the belief that men and women should be equal (Marshall & Scott, 2009). Feminist methodology focuses on the elimination or, in this case, illumination of sexist bias in research and education; where the masculine perspective is depicted as the standard or gender neutral perspective (Marshall & Scott, 2009). This directly informs the purpose of the

content analysis as science and informal science education is presumed to be ‘gender neutral’ by educators and parents (NSERC, 2015b).

A practical implication of the study is to identify gender symbolism in science toys, to provide a basis for more inclusive science promotion. This goal relates directly to a liberal feminist approach. Liberal feminism focuses on altering the current system in an attempt to enact change, or relieve some of the burdens of inequality (Gerson, 2002). This perspective informs the research in relation to a few key beliefs. This includes placing emphasis on gender inclusivity, multiple perspectives and truths and a need to create space for people to speak for themselves, when possible.

These feminist beliefs fit well with the critical realist beliefs of multiple vantage points. Critical realism presumes a person can only ever know a partial truth about a phenomenon based on their social location and specific perspective (Sayer, 1997). Therefore, by adding the perspectives together and assessing the commonalities of their experience it can uncover the true qualities of the phenomenon (Bhaskar, 1978). This allows for multiple theoretical vantage points, which can be used simultaneously without privileging one over others or consolidating their differences (Usher, 2000).

Critical realism sees knowledge as made up of three parts: the reality, the actual and the empirical (Delorme, 1999). The reality refers to the set of structures, mechanisms and their enduring properties that lead to a phenomenon. The actual is the phenomenon itself, including its expression and the context in which it occurs. Finally, the empirical is the interpretation of the phenomenon by an individual (Delorme, 1999).

Within the critical realist perspective, this allows for empiricist assertions that an object or phenomenon possess its own innate substance, by which it may be categorized and measured

according to its own virtue, thus, it is ‘the actual’ (Bhaskar, 1978). It also includes interpretist perspectives that one cannot separate themselves from their social location or the empirical (Delorme, 1999). It gets around their differences by using multiple perspectives to create the vantage point with which one can determine the virtue of an object and phenomenon.

As a scientist, the need to differentiate between truth claims that are rooted in observation and those that are attributed purely to interpretation is important to me. As a feminist, a belief in multiple vantage points is also very important. Furthermore, this perspective allows me to make assertions about the construction of gender in science that is applicable to perspectives and locations outside of my own.

3.2 Social Location and Researcher Perspective

Critical realist and feminist theories bolster the idea that each individual has a unique vantage point composed of their assumptions, biases, value emphasis and experiences (Rice & Ezzy, 1999). With this in mind, the following section looks to reveal both my social location and inspiration for the project. This knowledge is intended to help the reader contextualize the findings by revealing the perspective from which they were constructed.

I originate from a family that is interested in science. The top predictors of the science uptake of a child, is the support they receive for science interest and parental education in science. I hold a science degree, my mother also possesses a BSc. I was exposed to science through her interest and through our shared interest of science fiction and educational media. Science toys also existed within our home and were a major factor in my science interest. Finally, I leaked out of science shortly after gaining my degree due to a lack of fit.

Due to my experiences within science, I hold an insider position to the problem of fit and the use of science toys. I am both an insider and outsider to the gendered messages conveyed by

science toys. An insider is a researcher that has direct experience with the studied phenomenon in their personal life (Reinharz, 1992). Conversely, an outsider has no prior experience with the phenomenon or personal insight into the social location of people experiencing the phenomenon (Kunuha, 2000).

As a child who played with science toys and as a young woman who leaked out of science, I have firsthand experience with the complicated interplay of variables that affect these ‘choices.’ This position can, and did, provide valuable insider-knowledge and a starting point for research. It can also provide increased depth of analysis as the exploratory and familiarization stages are often completed informally prior to starting research (Rabe, 2003). Finally, insider position can provide ‘fire’ with which to drive research forward (Reinharz, 1992). This motivation makes the research produced by insiders more likely to be transferred and applied to real life contexts (Rabe, 2003).

Although there are many advantages to insider location, many theorists argue that such experiences can create biased interpretations of the data (Kanuha, 2000). This can lead to research that ignores important aspects of a phenomenon, in order to affirm a given hypothesis or proposition, in this case (Nilan, 2002). Many researchers believe an outsider location is essential for an objective stance on the research (Kikumura, 1998).

I do not believe researchers can be objective or shed their social location. I do however, recognize the value of completing an exploratory stage with few pre-conceived notions about what one will find. For this, I am glad that I hold an outsider position in regard to toy content.

In the last 25 years, the introduction of the Internet and consolidation of mass media, has created a new era of intensified commercial advertising (Schor, 2008). This has been accompanied with an intensification of gendered content in relation to toys and media for

children (Schor, 2004; James 2007). Due to my age, at the introduction of the Internet, I did not experience the mass media socialization and pinkification⁷ that girls currently experience. I also do not have children or younger siblings and I don't own a television. As such, I have not been exposed to toy content or media for nearly 15 years.

Overall, my insider position provides me insight into the barriers faced by girls while trying to form a science identity. Meanwhile, my outsider position provides me with substantially fewer preconceived notions surrounding gender cues in toys.

3.3 Dependability and trustworthiness.

According to Healy and Perry (2000), the quality of a study within each paradigm should be judged by the terms of that paradigm. In qualitative research, and especially qualitative research anchored on the assumption that a single person may not be objective, looks to achieve dependability and trustworthiness rather than inter-rater reliability and validity. Dependability, can be achieved by ensuring a salient and consistent application of procedures (Seale, 1999; Curtin & Fossey, 2007). This was achieved within this study through the use of a coding journal which defined each criteria, and by track all decision making processes, which was done through the use of a methods journal. To further facilitate a rigorous examination process, I used self-reflexive journaling to track and explore my beliefs and biases surrounding toy cues.

To ensure my work was trustworthy, I used the method of tri-angulation. Healy and Perry (2000) argue that the triangulation of several data sources and their interpretations with multiple perspective is very important within the realism paradigm. To facilitate this, I completed tri-angulation on the coding, on the methods used to investigate the data and on the final conclusions of my research.

⁷ Pinkification refers to the intensification of gendering content for girls. It gets its name from advertisers' pink-washing content intended for girls in order to indicate it as 'feminine'. This has led most non-pink content to be associated with maleness (Clarke & Higonnet, 1999).

For the coding I triangulated through *Facebook* posts in order to encompass a broader perspective. When I was unsure about an interpretation of a visual symbol, I posted the photo with a question about the cue online. I used a consensus rule with a minimum of three other people to make a decision. If a unanimous vote was not found, the photo was eliminated, which happened only once. This technique was also used for triangulating my interpretation of images in general. In this case I was looking to broaden the representativeness of the meanings I was attributing to the symbols, rather than looking for a concrete meaning as described above.

According to Patton (2002) triangulation can also be completed through multiple methods “triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data, including using both quantitative and qualitative approaches” (p. 247). I used both quantitative and qualitative methods to provide both an overview of the use of symbols across many cases and an in depth look at the relationship symbols had within a single photo. By providing two types of affirmation for major conclusions, this work provides multiple avenues for the reader to make sense of and gather evidence for the findings discussed in this paper.

Lastly, the findings were reviewed by both a man and a woman, and members of the scientific and non-scientific communities. I incorporated the suggestions provided from these reviewers into my analysis. An example of a comment was to describe girls as ‘distancing’ themselves instead of isolating themselves from equipment. Another example was that girls should be discussed as ‘novice’ science students instead of ‘outside’ of the science student role. Overall, the reviewers agreed with the interpretations of the images, all of the feedback provided was based on the language used to present findings. There were eleven changes made to the project following this process.

3.4 Sample and Coding

Sample. The purchase of science toys has been linked to parents actively seeking educational content for their children. It has also been related to children asking for toys in relation to exposure from peer relations, toy stores or advertisements (Seiter, 1993; Schor, 2004). With this in mind, the data was synthesised from online catalogues of well-known retailers for children's toys or educational content. The first two retailers: ToysRUs and Walmart were chosen because they were the two largest toy retailers in Canada (Fishman, 2006). It was presumed that these stores would be the most common place parents and children would come into physical contact with science toys. The final two retailers: Discovery Kids and Amazon Canada were commonly cited sources for the purchase of science toys on parenting blogs (Heffernan, 2014; Pinarski, 2014). As the Internet is the second most common place parents seek educational content (Schor, 2004), online retailers promoted by parents were chosen as the second data source.

Promotional content was retrieved from these sites on three separate occasions to allow for variations in toy content (including seasonal changes). For Walmart, ToysRUs and Discovery Kids an exhaustive search of their science toy and gendered toy categories was completed. For Amazon, a key word search⁸ with an exhaustive search method under each word heading was used. After retrieving all of the photographs, duplicates were removed and each photo was assigned a number. A sample of 400 science toys was drawn using a random number generator (random.org).

For the purpose of comparison, a sample of gendered toys, excluding science themes, was sought to act as a baseline. This baseline was used to assess the presence or absence of children

⁸ Key words included: science toys, science kits, astronomy toys, biology toys, botany toys, anatomy toys, engineering toys, building toys, chemistry toys, chemistry kits, physics toys, math toys, weather toys, weather kits, weather stations for kids, geology toys, and rock kits.

on packaging as a gendered symbol. A sample of 120 photographs, 60 masculine and 60 feminine, were drawn from the ToysRUs catalogue. This was done by entering the key words ‘boys’ or ‘girls’ into the search function and filtering the results by age group selecting ages 5-14. Random numbers were then drawn from the generator⁹ using the total number of toys in a given gendered category as a parameter. The toys on the site were numbered in accordance with the search parameters, thus, toys associated with the drawn numbers¹⁰ were downloaded and included in the sample. If a selected toy fit into the ‘science’ category or was cross-listed, in other words, the manufacture indicated it was for ‘boys and girls’ it was excluded and another number was drawn.

The dataset consists of 400 science toys and 120 gendered toys. The science toys included seven science categories: astronomy, botany, anatomy and animal or insect biology, chemistry, engineering and physics. Exclusion criteria for all toys included the absence of promotional content or a toy without a box; a low resolution photo; unobtainable download; absence of an English title or descriptive information; or the toys being categorized as books, movies or video games. Media-based toys were excluded because they provide supplementary information and context beyond the promotional content. These sources would therefore, call on more complex understandings of gendered constructs than the immediate visual cues.

Coding. The dataset was created by manually entering data into an SPSS¹¹ spreadsheet. For the purpose of this study a single case was composed of a single promotional photo for one

⁹ The random number generator was random.org

¹⁰ When a search was completed a pictorial list of toys was displayed in a specific order (same order every time-given the same search parameters). This list has a “displaying toys #-#” heading at the top of each page and each toy within the page is represented as a number between the two numbers displayed. All toys presented in the search represent a unique number between one and the total number of toys populated. These numbers were matched with the random numbers drawn to create the sample.

¹¹ Statistical Program for the Social Sciences (version 22) a program used to organize data and compute statistics for social research.

toy. The content analysis began with three main codes: target gender, mentor gender and colour of promotional content. All other codes were uncovered during the coding process, which consisted of a typical thematic analysis.

The analysis itself was adapted from Braun and Clarks (2006) methodology for thematic analysis. I began by familiarizing myself with the data, which was completed when I created the database for the quantitative analysis. Then I moved on to qualitative coding.

To begin, I combed each area of the photo looking for noteworthy symbols, or grouping of symbols (Fielding & Lee, 1998). If the gist of the symbolic relationship was not already captured by the quantitative analysis, I attributed a name to it in the side margin and made a note on the statistical spread sheet next to the case. I began tracking regularities in the raw data and when a symbol was re-occurring, I created a separate cell to track it within all the photographs. I then grouped together related primary codes and began to add cluster codes, which named the groupings and defined their inclusion and exclusion criteria. Once a short list of codes was created, I used the database sorting function to pull the cases where only that theme appeared and went back to the photographs for an in-depth look.

Each time I made a decision about a group of codes or cluster I wrote a note in the methods journal in order to track the ideas behind the choice and the change in the inclusion or exclusion criteria. These notes were used to highlight ideas about the themes, reflexive information, the research process and as a record keeping system to document the mental process underlying the analysis (Glaser & Strauss, 1967). This was a necessary procedure to ensure that all photographs were being analyzed using the same coding criteria and to track the evolution of the ‘making sense of’ process (Glaser & Strauss, 1967; Miles & Huberman, 1994).

The coding of content was an iterative process by which all definitions and coding schemes for variables were reworked. When a new variable was added all completed cases were manually back coded for the variable of interest¹². For variable revisions, syntax commands were used to collapse categories and recode numeric values. Lastly, manual coding was used when a new set of criteria was developed for inclusion or exclusion.

In general, these changes were based on the appearance of new data, reliability of the coding schemes and the appropriateness of the data for proposed analysis. A code book (Appendix A) was used to ensure uniform coding. It included each variable along with its operationalized definition and the exclusion and inclusion criteria for each category or sub-code.

Prior to running any statistical analysis the data was checked for entry error by comparing each case and its coding with the photo it represented. Frequency tables were also run to check for missing information or counts greater than the total N value. A few minor corrections were made to overall coding and there was no missing information for the original set of variables.

3.5 Measures

A total of 13 variables were coded during the content analysis. This included five main codes: target, mentor, type of toy, gendered content and shade of packaging. The first three main codes also contained sub-codes. Target included the sub-codes: target absent versus present, target-gender, number of targets and subtle cues. Mentor included the sub-codes: mentor gender and subtle cues. Finally, type of toy included sub-codes: discipline and type of toy. Subtle cues, gendered content and shade of packaging were investigated qualitatively and had a separate more detailed coding system. This will be discussed in the following section.

¹²This excludes combined variables that were created during the analysis process, in these cases data that was pulled by SPSS via syntax commands and used to populate the data.

Target. For the purpose of this study a ‘target’ refers to the presence of a youth or many youths in the promotional content i.e. who the toy is targeted toward. This measure included the sub-codes target absent versus present, target-gender, number of targets and subtle cues (Table 3).

Target absent versus present. Griffiths (2001) found that feminine toys tended to portray the child on the package interacting with the toy, where masculine toys displayed the toy alone. This was suggested as another subtle cue for assessing targeted gender. For this measure, the ratio of targets absent versus present was used to signify the possible gendering of the toy group. Comparative ratios were drawn from feminine toys, masculine toys and a third ratio of even representation was used. Within this category a discipline would be considered matching masculine symbols if it matched a distribution of 86% absent and 14% present. In contrast, a discipline would be considered feminine if it matched a ratio of 41% absent and 59% present and the targets present were not predominantly boys. It would be considered neutral if it matched even representation and neither feminine nor masculine distributions.

Target gender. Gender signifiers were used as observable representations of gender in regard to targets. These signifiers are indications or symbols that are used to convey the embodiment of masculinity or femininity (Blackburn, 2005). Specifically, they are qualities that are highly correlated with a particular gender, which are recognized by the general public (Blackburn, 2005). The signifiers or symbols used to determine gender for this study are included in Table 2.

Table 2 Gender Symbols for Targets and Mentors

Symbol Type	Masculine symbols	Feminine symbols
Colour of clothing	Dark blue, red, black, gray, brown	Pink, purple, pastels
Type of clothing	Bow ties or neck ties, ball caps, loose fitting clothing	Dresses, skirts, hair bows, tight or revealing clothing
Body signifiers	Accentuated muscles, square jaw, triangular body shape, gritted teeth, furrowed brow	Sexualized legs, breasts, hour glass shape, accentuated lashes or lips, beauty marks
Body stance	Crouching legs open, flexing, lifting, sitting legs open, active or outward turning (in a non-sexual manner)	The 'reclining nude' position, legs crossed when sitting, hand on hip with chest out, passive or inward turning

1

Table 3 Target Codes

2

Variables	Levels	Description	Pearson's Test for Independence	Chi-Square One Variable Goodness-of- fit Test	Qualitative Analysis
Absent versus Present	Absent Present	No children present Child present	X	X	-
Target Gender	Boys only Girls only Both N/A	Single or multiple boys, no girls Single or multiple girls, no boys Girls and boys, in any ratio No child present	X	X	X
Number of Targets	Single child Multiples Even Outnumbered N/A	One child on package Multiple children of one gender Even number of boys and girls One gender outnumbered the other when both are present No child present	X	X	-
Subtle Cues					
Prominence	Boys Girls Even N/A	Most prominent target is a boy Most prominent target is a girl Children equally prominent No child present	-	-	X
Active versus passive	Active Passive N/A	Manipulating the equipment Not manipulating equipment No children present	-	-	X
Role	Expert Novice Model N/A	See definitions in code book	-	-	X

Target gender was divided into three sub-codes it included boys only, girls only and both. Boys only was used when either a single boy or multiple boys were present on the package but no girls were present. Girls only was used when a single girl or multiple girls were present on the package but no boys. Both was used when boys and girls were present regardless of the ratio in which they appear.

Number of targets. Another symbol used to indicate main target audience is the number of people presented on the package from a given demographic, i.e. one demographic outnumbering the rest, or multiple targets of the same demographic in the absence of others (Jameson, 2009). To evaluate this form of subtle targeting the following sub-codes were used: a single child on package, multiple children, even and outnumbering. A single child was defined as one child presented alone on the package. Multiple children was defined as several children of the same gender on a package in the absence of another gender. The term ‘even’ was used to depict multiple children on the package, where two genders were represented in even numbers. Finally, outnumbering was used to denote a situation where two genders appeared on the packaging but one gender outnumbered the other.

Subtle cues to denote target. According to the literature, advertising will often use subtle cues to signify the main target or character for the scene and thus, the main audience for the product (Jameson, 2009). These subtle cues include a person centred in the camera angle (Koivula, 1999), being larger than others, being in closest proximity to the product or interacting with the mentor (Jameson, 2009). This was coded under ‘prominence’ (Table 3).

Research has also found that portraying a character as ‘active’ either by using the product or demonstrating its use signifies that demographic as the targeted audience (Griffiths, 2001). This was coded under active versus passive. Active was defined as holding, using, manipulating

or instructing others on the use of a product. Passive was defined as lightly touching, not touching or watching the product but not using it.

Finally, the role of the youth in the photo was evaluated to see if boys and girls represented expert, novice, or modeling roles. A novice or student role was defined as youth portraying a role where they are being taught or appear unsure or unknowledgeable about a topic. Being taught was defined as listening, looking at, or writing notes when orientated toward a mentor or another child who is holding an instructional stance. Being unsure included 'I don't know' gestures such as shoulder shrugs, or the character standing with their arms by their side lifting their forearms and hands towards the sky. This category also included nervous facial expressions and the character distancing themselves from equipment.

Expert roles were defined as teaching roles, where children were portrayed demonstrating science to other children or the viewer. They included self-assured looks and pointing gestures. They also included a character manipulating or holding equipment out toward other characters or the camera in a 'showing' motion. In these cases, children were considered to be knowledgeable about the object and teaching the viewer or other children.

The modeling role included characters that were portrayed as an aesthetic device, standing next to but not using the equipment. These characters look at the camera in a pose, with a smile designed to be aesthetically pleasing but not presumed to convey the child as genuinely enjoying themselves. It includes a character appearing unengaged or holding a facial expression that is not reactive to the equipment or scene, but rather to the camera. These characters appear to be unaware of or unconnected to their surroundings and seem to appear for the sake of the viewer. This would be akin to models in show cases.

Mentors. Mentors were defined as humans that were older than the target, including young adults or adults or humanlike characters that occupied an adult role such as scientist, superhero, model or caretaker. Mentors had two sub-codes: mentor gender and subtle cues (Table 4). Number of mentors was not tracked formally as only five photographs had multiple mentors.

Mentor gender. Gender signifiers were used as observable representations of gender in regard to mentors. The same cues used for target gender were used for mentor gender and can be found in Table 2. In a few cases symbols were ambiguous, this only occurred when the character was non-human or masked, therefore, in these instances they were coded ‘unknown.’

Subtle cues to denote mentor. The same subtle cues that were tracked for targets were tracked for mentors: prominence, active versus passive stance and mentor role. Two other cues were added to this list: role of caregiver under mentor roles and mentor clothing (Table 4). These themes emerged in the qualitative analysis and were back coded.

Mentor clothing had two levels: everyday clothing and science clothing. Everyday clothing was defined as casual or fashion clothing appropriate for the public realm that does not denote a specific occupational role (Shteir & Lightman, 2006). Science clothing included the following: lab coats, stethoscope, scrubs, nurse uniform, hard hats, overalls, construction wear, magnifying glass, science-related t-shirts and safety goggles. Glasses, bow ties and pens were also considered science clothing when paired with other science symbols such as beakers.

Table 4 Mentor Codes

Variables	Levels	Description	Pearson's Test for Independence	Chi-Square One Variable Goodness-of-fit Test	Qualitative Analysis
Gender					
	Men only	Single or multiple men, no women	-	X	X
	Women only	Single or multiple women, no men			
	Both	Men and women, in any ratio			
Subtle Cues					
Prominence	Men	Most prominent target is a man	-	-	X
	Women	Most prominent target is a woman			
	Even	Mentors equally prominent			
	N/A	No mentor present			
Active versus passive	Active	Manipulating the equipment	-	-	X
	Passive	Not manipulating equipment			
	N/A	No mentor or equipment present			
Role	Expert	See definitions in code book	-	-	X
	Novice				
	Model				
	Caregiver				
	N/A				
Clothing	Everyday Science	See definitions in code book	-	-	X

The role of caregiver was defined as depictions of mentors taking care of, nurturing, protecting and accompanying children in a supervision role. For these roles emphasis was placed on caring for or supporting the child in ways that were not linked to active instruction in science. This included protective stances such as leaning over children, aiding a child with mobility, driving children places and the provision of resources for the sake of fulfilling needs. These roles depicted the primary purpose of the mentor as a role of nurturance rather than conveyance of expertise or science related knowledge.

Type of toy. Discipline and type of toy fell under this category. Discipline was coded for science toys only and denoted the scientific discipline the toy represented. Type of toy was used to differentiate the three samples: masculine, feminine and science toys (Table 5).

Gendered content. Gendered content includes themes such as ‘princess’ or ‘warrior,’ that become associated to specific genders due to the prominence of their representation in gender specific toys or media (Griffiths, 2001). Masculine content had themes that centred on aggression, cars, gross things such as ozzs and goos, as well as sports. Feminine content included esthetics, domestic and social relationships (Griffiths, 2001). See Appendix A.

Shade of packaging. Shade is traditionally defined by how light or dark a colour is in comparison to other colours (Stevenson, 2010). According to Griffiths (1998), toys targeting boys were gloomy, dark and tonal and toys directed towards girls were bright or pastel. This variable looks to assess if science toys follow the trends set forth by masculine toys, feminine toys or if they are a mix between the two. For this, three shades were identified: dark, pastel or bright and neural (Table 5).

Table 5 Toy Codes

Variables	Levels	Description	Pearson's Test for Independence	Chi-Square One Variable Goodness-of-fit Test	Qualitative Analysis
Toy Type					
	Discipline				
	Astronomy	See code book for definitions (Appendix A)	X	X	X
	Botany/Ecology				
	Anatomy				
	Engineering				
	Physics				
	Chemistry				
	Toy type				
	Science toy	Toy with science themes	X	X	X
	Masculine toy	Designated boys' toy			
Feminine toy	Designated girls' toy				
Gendered Content					
	Masculine	Masculine themes	-	-	X
	Feminine	Feminine themes			
	N/A	Neutral/No themes			
Shade					
	Dark	Colours are dark	-	-	X
	Pastels	Colours are pastel			
	Neutral	Neither dark nor pastel			

3.5 Analysis

Three types of analysis were used to examine gender symbols in science toys they were the Pearson's Chi-square Test for Independence, the Chi-square One-variable Goodness-of-fit Test and a qualitative thematic analysis.

Pearson's test for independence. The test for independence was chosen because it had the greatest validity for large analyses, 2x2 or greater (Howell, 2002). This fit the parameters of the variables under study. It also provided a measure of association that allowed me to test whether the presence of variables appearing together was a legitimate trend rather than fluke or happenstance. For this test the significance level was set at $\alpha=0.05$, meaning that significance scores below 0.05 would indicate likelihood of association and those above would indicate independence of measures.

Cell significance was computed using Bonferroni adjusted p-values, which controlled for family-wise error rate, reducing the likelihood of falsely rejecting the null hypothesis because of additive error from running multiple related tests (Howell, 2002). Finally, the Pearson test for independence was followed by a Creamer V statistic, which estimated the magnitude of effect on significant findings. Creamers V was again optimal for a larger number of levels within two variables (Liebetrau, 1983). For this statistic a score close to zero would indicate little association, in contrast, a score close to one would indicate a high association (Agresti, 1996).

Together the Pearson's test for independence and Creamers V were used to determine if 'type of toy' (gender or science discipline) were associated with absence or presence of a target, target-gender and the outnumbering of a single gender. Mentor-gender could not be computed using this method. Analysis of this data found that the magnitude of difference between the

variable levels 'masculine mentors' 'feminine mentor' and 'both' was so great it violated test assumptions regarding cell frequencies.

Several of the above tests had a problem of low cell frequencies. The assumptions of the test require that no more than 20% of cells have expected frequencies less than 5. All of the tests using discipline as a variable, except for target absent or present, violated this assumption. Hence, the analysis had to be rerun without botany and astronomy. These disciplines were examined qualitatively instead, the implication of this move will be discussed in subsequent chapters.

Chi-square one-variable goodness-of-fit test. The one variable test was used to determine differences between specific levels of a single variable. This technique was employed when a) a more detailed analysis of the independence test results was required to investigate differences between levels of a single variable, and b) a specific variable could not be investigated using the test for independence because too many cells had low frequencies. It is important to note, that the one-variable test has the same assumptions as the test for independence, thus, small cell frequencies within a variable were still an issue. However, because a single level of the variable could be tested at a time it could avoid the accumulation of low cell frequencies through strategic choices in terms of inclusion.

Qualitative analysis. As indicated above, qualitative analysis was used to examine the independent variables in relation to botany and astronomy and to examine the differences between masculine, feminine and both mentors. Three other variables were moved into qualitative analysis they were: prominence, gendered content and shade. These variables were highly context dependant and although quantitative analysis provided useful information it failed to provide the rich level of detail required to make sense of the trends that appeared. Finally,

target gender was also examined using qualitative analysis, to provide richer detail on subtle differences in the way gender was performed by youth. The same analysis used to thematically code variables, was used to complete an in-depth analysis of the photographs.

4 Chapter: Findings

4.1 Target

Target absent versus present. A Pearson Chi-square Test for Independence was performed to determine whether a child was present or absent from toy promotional content in equal quantities. Children were absent from packaging 1.09 times more often than they were present, which did not constitute a significant difference in distribution, $\chi^2(1, 400) = 0.810$, $p = .368$.

The same test was run using the expected distribution found in gendered toys intended for girls. Gendered toys refer to a sample of non-science toys drawn from the regular catalogue of ToyRUs that were designated as a toy for boys or a toy for girls. This sample was used as a comparison for science toys to see if the absence or presence of children on the package was a gendered symbol as is found in gendered toys. In this case, a significant result would suggest that science toys differ from the proportion of children present on feminine toys.

The distribution of gendered toys intended for girls, was 41% of toys with children absent and 59% with children present. This test found that there was a significant difference between expected and observed frequencies, $\chi^2(1, 400) = 22.11$, $p = .001$. Children were absent from packaging more often than expected. The test was also run using the distribution for gendered toys intended for boys, which had 86% of toys with children absent and 14% with children present. This also led to a significant difference between expected and observed frequencies, $\chi^2(1, 400) = 357.92$, $p < .000$. In this case, children were absent from packaging less often than expected.

Absent versus present and discipline. The sample was then divided into disciplines. Chi-square Goodness-of-fit tests were run to determine if the frequencies that children were absent or present matched any of the expected distributions mentioned above.

Table 6 Child Absent versus Present by Discipline

Chi-Square Goodness-of-Fit Tests							
Discipline	Odds Ratio	Equal Distribution		Girls Gendered Toy Distribution		Boys Gendered Toy Distribution	
		χ^2	p	χ^2	p	χ^2	p
Astronomy	1.9	4.79	.029*	12.42	.000**	14.55	.000**
Botany/Ecology	4.6	20.48	.000**	35.34	.000**	0.50	.478
Anatomy	0.82	0.60	.439	0.46	.498	79.63	.000**
Engineering	1.09	0.19	.666	4.82	.028*	76.60	.000**
Physics	1.7	3.00	.083	9.45	.000**	20.57	.000**
Chemistry	0.47	13.95	.000**	3.33	.07	251.31	.000**

*significant at the $\alpha=0.050$ level **significant at the $\alpha=0.010$ level

When analyzed by discipline, it was found that children were more likely to be absent from photographs than present. Exceptions to this rule were anatomy, which had slightly more present than absent and chemistry, which had significantly more present than absent making it most in line with distributions from gendered toys intended for girls (Table 6). On the other side of the spectrum botany and ecology had a substantially larger frequency of ‘absent’ toys than other toys categories making it most in line with gendered toys intended for boys.

Astronomy toys. Children were absent from packaging 1.9 times more often than present, which represents significantly different distributions, $\chi^2 (1, 47) = 4.79, p = .029$. These distributions were also significantly different when both girls and boys toys were used as a reference. In the former, children were absent more than expected and, in the later, they were present more than expected.

Botany and ecology toys. Children were absent from promotional content 4.6 times more often than they were present. This differed significantly from the expectation of equal distribution, $\chi^2 (1, 50) = 20.48, p < .000$. It also differed from toys for girls, as children were absent from science toy packaging more than expected. These frequencies did not, however, differ from the frequencies present in toys intended for boys.

Anatomy toys. Children were absent from packaging 1.18 less often than they were present, this did not constitute a significant difference in frequencies, $\chi^2 (1, 60) = 0.60, p=.439$. When toys for girls were used as reference, frequencies were still not considered significantly different. In comparison to toys intended for boys, distributions were highly significant, with children absent substantially less often than expected.

Engineering toys. Children were absent from packaging 1.09 times more often than they were present, this did not equate to a significant difference between frequencies, $\chi^2 (1, 86) = 0.19, p=.666$. There was a significant difference between observed frequencies and expected values of toys for boys and toys for girls. Again, there were more children absent than expected in toys intended for girls and less children absent than expected in toys intended for boys.

Physics toys. Children were absent from packaging 1.7 times more often than they were present, this was not significant difference, $\chi^2 = (1, 48) = 3.00, p=.083$. There was however, a significant difference between observed values and the expected frequencies of toys for boys and toys for girls. The trend of having more children absent than expected in toys for girls and less children absent than expected in toys for boys, continued.

Chemistry toys. Children were present on packaging 2.1 times more often than they were absent, this was a significant difference between frequencies, $\chi^2 (1, 109) = 13.95, p<.000$. This also constituted a significant difference when compared to expected frequencies of toys intended for boys. It failed to be significantly different from expected frequencies of toys intended for girls.

Gender of target. A one variable chi-square test was run on all science toys with a child present on the package. This was done to determine if there was equal gender representation between boys, girls and both genders. There was a significant difference between the frequencies $\chi^2(2, 191) = 30.17, p < .000$. Packages that depicted only masculine characters occurred 3.0 times more often than packages with only feminine characters and 1.5 times more often than packages with both genders present. There were significantly fewer girls and significantly more boys than expected. There was no difference between expected and observed outcomes when both genders were present on the package.

Gender of target and discipline. A Pearson's Test for Independence was run to determine if gender representation and discipline were associated. For this test, astronomy and botany were excluded due to the small number of target-present toys. There was a significant difference between expected and observed values $\chi^2(6, 166) = 31.78, p < .000$. Therefore, the null hypothesis that gender and discipline are independent measures was rejected. The strength of the association was measured using a Creamers V Statistic. A moderate effect size was found, $\phi = 0.31$. A summary of the findings for target by discipline can be found in Table 7.

Table 7 Target Gender by Discipline

Pearson's Chi-square Crosstabulation						
Discipline	Girl Only		Boy Only		Both	
	Adj. Res	p	Adj. Res	p	Adj. Res	p
Anatomy	-1.7	.089	-1.8	.071	3.1	.000*
Engineering	-0.7	.483	3.4	.000**	-3.1	.000*
Physics	1.9	.057	2.5	.012	1.1	.271
Chemistry	3.2	.000*	-3.1	.000*	0.9	.368

* Bonferroni adjusted p-value for $p < 0.05$ was $p < 0.0056$ ** Bonferroni adjusted p-value for $p < 0.01$ was $p < 0.0008$

Anatomy toys. It was found that both genders were present significantly more often than expected. Comparatively, both genders were present 1.6 times more often than boys and 9.5 times more often than girls. Boys were also present 6.0 times more often than girls. This was

found to be a significant difference $\chi^2 (1, 14) = 7.14$ $p = .008$ when a chi-square one variable test was conducted.

The qualitative analysis found that boys were displayed more prominently when both genders were present. Specifically boys occupied the foreground of photographs. I also found that the human anatomy-figures, such as skeleton like figures, were unanimously depicted as male. Girls and boys showed equal likelihood of being in active stance. In a handful of photographs, girls were presented manipulating the equipment, while their masculine counterpart was observing. This did not occur in other disciplines.

Engineering toys. Both children were present significantly less often than expected and boys were present significantly more. Specifically, boys were present 5.0 times more often than both and 6 times more often than girls. There was no significant difference between the frequencies of girls and both using a chi-square goodness-of-fit test, $\chi^2 (1, 11) = 0.91$ $p = .340$.

Qualitative analysis found that boys were presented in a nearly uniform way. They were found to be looking at the equipment intensely while manipulating it in some way. They had self-assured looks on their faces or a 'that's awesome' expression. In contrast, girls were often found posing beside the equipment and looking directly at the camera with a smile, not related to the enthusiasm for the activity but appeared to be posing for a picture. When both genders were presented the boy was depicted in action and the girl was usually inactive, or less active than the boy. In all but one photo boys were also presented as more prominent as they were centred in the camera angle, in the foreground or larger in size.

Physics toys. All of the gender categories failed to differ significantly from expected values in the 2x4 crosstabulation. However, post-hoc chi-square goodness-of-fit tests were used to do comparative analysis between the levels of the gender variable. These tests revealed that

boys were present 14 times more often than girls, which equated a significant difference, $\chi^2(1, 14) = 11.27, p < .000$. It also found that boys were present 3.5 times more often than both genders, which was also a significant difference, $\chi^2(1, 18) = 5.56, p = .018$. The analysis between girls and both genders could not be completed as their frequencies were too low to run meaningful statistical analysis on. It is worth noting, that there were zero girls present in physics toys. In comparison, both boys and girls were present on four toys. Each of the 'both gender' toys were multi-discipline, but mostly physics. This contrasted with toys that had only masculine characters, which were never cross discipline.

There were only a few trends in the qualitative analysis. Girls only appeared in combination with boys and never by themselves. These photographs were uncommon and the children were depicted in recreational activity rather than science activity. For example, riding a roller-coaster or playing soccer. Single boys were always in a science-related active stance and were looking at the camera more often than other disciplines. This differed from the girls 'looking into camera' gaze identified previously. Girls were presented posing beside equipment with their bodies oriented toward the camera. In the case of boys, it appears as if the photographer momentarily disturbed their work, their body was angled downward toward the equipment and they were mid-way through manipulating the equipment.

Chemistry toys. Both gender categories were found to be significantly different from expected values in the 2x4 crosstabulation. In this test girls were present more often than expected and boys were present less often than expected. When follow up tests were completed to compare different levels of the gender variable, boys were found to be present 1.4 times more often than girls did. This did not constitute a significant difference $\chi^2(1, 74) = 1.39, p = .238$. Similarly, when both genders were examined in relation to boys only, no significant differences

were found $\chi^2 (1, 55) = 0.018, p = .893$. The same occurred when compared against girls only, $\chi^2 (1, 47) = 1.72, p = .189$.

The qualitative data uncovered that both genders were portrayed in active stance in a nearly equal proportion, with boys slightly more active. The level of activity commonly differed in this discipline as boys were shown in an elevated level of activity, such as manipulating equipment, when girls were merely touching it. Likewise, boys were found to be looking at the equipment in all but four photographs. Three of these four had boys holding out the science experiment in his hands as if they were showing the viewer.

Girls were more likely to be looking at the camera even when they were touching equipment. The exception to this rule occurred when multiple children were present, in which case, accompanied the boys in looking at equipment but maintained a posed smile. Girls were never portrayed showing the audience the science they were doing. Boys were also more likely to be portrayed prominently in comparison to girls.

Botany toys. There were too few target-present photographs to conduct statistical analysis for this discipline. There were nine toys with a target present on the package. Of those, one or 11% of botany photographs with targets depicted only feminine characters. Similarly, two or 22% contained only masculine characters. Finally, six or 67% depicted both genders. All instances where both genders appeared, girls and boys were evenly represented. Both genders were as likely to be touching equipment, or portrayed in active stance.

Astronomy toys. Astronomy toys also had too few targets to make meaningful assertions. Altogether there were 16 target present toys in this category. Of these, three or 16% portrayed only feminine characters, six or 32% depicted only masculine characters and another seven or 44% depicted both boys and girls. This fits the current trend in the statistically verified data

where girls are present half as often as their counterparts, with the exception of chemistry at 42%. Both genders were commonly portrayed in an active observing stance and no obvious trend of prominence was found across the discipline.

In each of the disciplines, boys were present on packaging more often than girls. The most pronounced differences were physics and engineering. Chemistry and anatomy were most likely to have both genders present. Botany and astronomy had too few targets to make concrete assertions about the discipline based on the sample. Noteworthy trends were that chemistry had nearly equal representation, with slightly more boys, in terms of single targets. Anatomy had the second highest proportion of boys, which was roughly equal, but slightly fewer than both.

Number of Children. A Pearson's test for independence was run to determine if gender of target and number of targets present were associated. There was a significant difference between expected and observed values $\chi^2(1, 121) = 3.91$ $p = .048$. Therefore, the null hypothesis that gender and number of targets are independent measures was rejected. A Creamers V statistic was completed post-hoc to determine effect size. It was found that $\phi = 0.18$, which constitutes a small effect size.

Girls. Follow up one-variable chi-square tests were run to determine if there was a difference between multiple and single representation when a package contained only girls¹³. In this case, a single girl¹⁴ figure was present twice as often as multiple girls¹⁵, which was significant $\chi^2(1, 31) = 3.90$, $p = .048$. In comparison to representation¹⁶ of both (boys and girls)

¹³ Girl-only packages- refer to toys that have single or multiple girls present but no boys (the same format follows for boy-only packages).

¹⁴ A single girl- refers to the presence of a girl on the package in the absence of other girls or boys, but does not preclude the presence of mentors (single boys follow the same format but with boys).

¹⁵ Girl multiples- signify the presence of two or more girls and the absence of boys on the package (the same format follows for boys-with the absence of girls). Again this does not include mentors.

¹⁶ Representation of both- includes both boys and girls on the package including situations where boys outnumber girls, girls outnumber boy and even representation and mentors are not counted as either gender in this measure.

multiple girls were not significantly different $\chi^2 (1, 18) = 0.22, p = .637$. Single representation of girls also was not significantly different from representation of both boys and girls, $\chi^2 (1, 28) = 3.30, p = .070$.

Boys. Follow up one-variable chi-square tests were run to determine if there was a difference between multiple and single representation of boys when the packaging contained only boys. It was found that single representation of boys was present 5.0 times more often than multiple boys, $\chi^2 (1, 91) = 40.89, p < .000$. In comparison to representation of both boys and girls, multiple boys were present an identical number of times $\chi^2 (1, 30) = 0.00, p = 1.000$.

Both genders. Several one-variable chi-square tests were computed using toys with both boys and girls present on the package. Basically, I looked to determine if there was a difference in the frequencies of girls outnumbering boys¹⁷, boys outnumbering girls and equal numbers of each gender. A significant difference between the three categories was found $\chi^2 (2, 70) = 37.06, p < .000$. When follow up chi-square tests were run it was found that boys outnumbered girls 1.9 times more often than the reverse, this did not constitute a significant difference $\chi^2 (1, 23) = 2.13, p = .144$. When even representation and girls outnumbering were compared, there was a highly significant difference $\chi^2 (1, 55) = 27.66, p < 0.000$ with even representation¹⁸ present 5.9 times more often than girls outnumbering. The same was found when comparing boys to even representation, $\chi^2 (1, 62) = 16.52, p < 0.000$ with even representation present 3.1 times more often than boys outnumbering.

Number of targets and discipline. A Pearson's test for independence was run to determine if the number of targets was associated with discipline. Due to the low cell frequencies for astronomy, botany and physics they were excluded from the analysis. There was a significant

¹⁷ Outnumber refers to a situation where both genders are present and there are more of one gender present, excluding mentors.

¹⁸ Even representation- an equal number of each gender is present (excluding the mentor).

difference between expected and observed values $\chi^2(6, 147) = 31.46$ $p = .000$. As a result, the null hypothesis that number of targets and discipline are independent measures was rejected. A Creamers V statistic was completed to determine effect size. It was found that $\phi = 0.33$, which constitutes a moderate effect. A summary of the findings for the number of targets by each discipline are found in Table 8.

Table 8 Number of Targets by Discipline

Pearson's Chi-square Crosstabulation (Adjusted)								
Discipline	Single child		Girl Multiple		Boy Multiple		Even	
	Adj. Res	p	Adj. Res	p	Adj. Res	p	Adj. Res	p
Anatomy	1.7	.0164	-1.6	.1096	2.0	.0455	2.3	.0215
Engineering	4.8	.0000**	-0.9	.3681	-1.7	.0891	-3.5	.0005**
Chemistry	-2.2	.0278	2.1	.3573	-0.2	.8415	1.2	.2301

* Bonferroni adjusted p-value for $p < 0.05$ was $p < 0.0042$ ** Bonferroni adjusted p-value for $p < 0.01$ was $p < 0.0008$

Anatomy toys. There were no significant differences between expected values and observed values for any of the levels in the 3x4 crosstabulation. A post-hoc comparative analysis was run using a chi-square one variable test to see if hidden associations existed between these levels. It was found that boy multiples were present 10.0 times more often than girl multiples, which was a significant difference, $\chi^2(1, 11) = 7.36$, $p = .007$. There were no significant differences for the comparison between boy multiples and even representation $\chi^2(1, 22) = 0.18$, $p = .670$; and boy multiples and single targets¹⁹ $\chi^2(1, 20) = 0.00$, $p = 1.00$. There was also no significant differences when boy multiples were measured against single boy targets $\chi^2(1, 12) = 0.36$, $p = .549$.

Comparative analysis of girl multiples and even number of targets found that girl multiples were present 12.0 times less often than even numbers, $\chi^2(1, 13) = 9.31$, $p = .002$. It was also found that girl multiples appeared 10.0 times less often than single targets $\chi^2(1, 11) = 7.36$,

¹⁹ Single target- refers to the presence of a single child on the package (boy or girl) regardless of the presence of a mentor.

$p=.007$, however, this difference disappeared when multiple girls were compared to single girls, rather than single targets of either gender. In this case each level was found to have a frequency of one. Finally a comparison between single girl and single boy targets, found that single boys were present 9.0 times more often than single girls, which was also a significant difference $\chi^2 (1, 10) = 6.44, p=.011$.

Engineering toys. There were significant differences between expected values and observed values for single targets. In follow up analysis using a chi-square one variable test, single targets were found to be significantly different from all other categories. Single boys were present 8.3 times more often than boy multiples, $\chi^2 (1, 37) = 22.70, p<.000$; 11.0 times more often than girl multiples $\chi^2 (1, 36) = 22.73, p<.000$; and 33.0 times more often than even numbers of targets $\chi^2 (1, 34) = 30.12, p<.000$.

When single girl and single boy targets were compared the boys were present 7.3 more often, which was also significant $\chi^2 (1, 33) = 18.94, p<.000$. There were also significant differences found between single and multiple boys with single boys present 29.0 times more often than multiples, $\chi^2 (1, 30) =$, $p<0.000$. The frequencies for single girls, girl multiples, even targets and boy multiples were all too small to complete comparative analysis with each other.

Chemistry toys. There were no significant differences between expected values and observed values for any of the levels of independent variable in the cross tabulation. A post-hoc comparative analysis was run using chi-square to see if there were associations between each pair of variables. Boy multiples were only 1.08 times more likely to appear on packages than girl multiples, which was not a significant difference, $\chi^2 (1, 25) = 0.40, p=0.841$. Boy multiples were also present 1.46 times less often than even representation, which was not a significant difference $\chi^2 (1, 32) = 1.125, p=0.289$. They were however, present 2.2 times less often than single targets

(boys or girls), which constituted a significant difference $\chi^2(1, 42) = 6.095$, $p = 0.014$. When compared with boy singles, the gap between the two frequency remains at 2.2, which is not a significant difference in this case $\chi^2(1, 26) = 3.85$, $p = 0.050$.

Comparative analysis of girl multiples and even number of targets found that girl multiples were present 1.58 times less often than even numbers, which was not significant at the $\alpha = 0.05$ level: $\chi^2(1, 31) = 1.58$, $p = 0.209$. It was also found that girl multiples appeared 2.4 times less often than single targets, boys or girls, which was again significant $\chi^2(1, 41) = 7.49$, $p = 0.008$. When this comparison was made with girl singles and multiples, the difference is no longer significant. With girl singles present only 1.57 times more often than girl multiples $\chi^2(1, 18) = 0.889$, $p = 0.346$. A comparison between single girl and single boy targets, found that single boys were present 1.6 times more often than single girls, which was also not a significant difference $\chi^2(1, 29) = 1.69$, $p = 0.194$. Finally, a look at even number of targets and single targets revealed no significant differences between the two, $\chi^2(1, 48) = 2.08$ $p = 0.149$.

Botany toys. Due to the low numbers of targets present this variable could not be included in the statistical analysis. There were a total of four photographs with both genders present and in each case there was one boy and one girl. There were two photographs with a single child portrayed on the package in both cases the child was a boy.

Subtle cues. The following section will look at covert cues such as prominence, active versus passive stance and roles of children within science toys. These analyses apply to the grouping of science toys as a whole, as the qualitative analysis of individual disciplines was discussed above.

Prominence of target. In 27% of the target-present photographs both genders appeared. Despite even representation, the role depicted by each gender was substantially different. For

example, girls were much more likely to be further away from the centre of the camera or off to one side, they were often smaller in size and placed into the background rather than the foreground (Photographs P01, P04, P20). In general, girls were also placed farther from the equipment or mentor. This was coded as ‘prominence’ in the scene. Boys were the most prominent figure in 41% of the photographs. Girls were most prominent in 28% of photographs and no visible difference in prominence occurred in 32% of the photographs.

Active versus passive stance. There were some differences between who was ‘doing’ science and who was ‘watching’ science. Boys were found to be touching equipment or using equipment or active three times more often than girls and twice as often as both genders. Both genders were also twice as likely to be ‘active’ than girls. Girls were active in about 20% of photographs, boys were active in about 50% of photographs and both were active in 43% of photographs. Secondary boy characters-which commonly deviated from the typical masculine character who was white and had brown hair- were less likely to be using equipment, but still appeared to be more active than girls.

There was a distinct difference in the active stances between boys and girls. Girls were often found to be touching equipment lightly, or hovering over it, rather than manipulating it. Boys were almost always found to be touching or manipulating the equipment. Although the level of contact differed between photographs boys regularly maintained a more intimate level of contact than girls, regardless on the level engagement depicted. For example, in photo P03, the boy is touching the plant and the girl has her hand reaching out to the plant but touching nothing. Similarly, in photo P04 the girl is touching the side of the dish and the boy is manipulating the circuit. Girls were also more commonly found to be looking at the camera instead of the equipment when in contact with it (Photo P06).

Illustration 1 Prominence of Characters

There were drastic differences in the characters 'gaze' in terms of looking at the camera, versus looking at the science toy. Nearly all of the boy characters, with the exception of some physics toys, were looking at the science toy. However, the majority of girls were either looking at the camera, or other people.

Illustration 2 Masculine Targets Portraying Active Stance

Illustration 3 Feminine Targets Portraying Passive, Audience Focused Stance

There were also marked differences in the facial expressions of the youth. When girls were looking at the camera or other people they tended to have posed smiles where they appeared to be modeling for a photo, rather than expressing joy for the activity (Photo P06). In contrast, boys tended to have thrilled looks that appeared to be related to the activity at hand (Photo P05).

Roles portrayed. Girls regularly portrayed roles that signified their lower skill levels, including student or novice roles. For example, when girls were looking at the equipment or experiments they regularly had surprised, clueless or nervous looks. These expressions included eyebrows raised with either their mouth open, in a frown (Photo P07), or forming a posed smile (Photo P06).

Occasionally these expressions were accompanied by poses where girls' bodies were leaning away from or distancing themselves from the equipment (Photos P07 and P08). Another common pose was girls raising their hands in a shrugging 'I don't know' posture (Photos P09 and P12). Surprised and posed-smile expressions were most common when girls were presented alone on a package. Nervous, unsure, or 'unknowing' expressions occurred only in group photographs where boys were present. Furthermore, every photo with a girl performing a 'unknowing or nervous' expression, was accompanied by a boy character in the 'expert' role showing the girl, mentor or other students how to do science (Photo P03-P05).

Illustration 4 Depiction of Expert and Novice Roles

Boys never looked shocked, surprised, or worried. Instead, they tended to be posed in thinking postures; pointing, showing or 'explaining' stances; or in 'action' shots (Photos P05, P07-P09). They had either self-assured looks, with eyebrows slanted upward in the middle, smiling; thrilled looks with eyebrows up in a sign of excitement; or with eyebrows down focusing intently on the toy, smiling excitedly (Photo P04, P05, P07-P09). Thrilled facial expressions in conjunction with action shots tended to be used on photographs where boys were

presented alone (Photo P05). Self-assured looks with explaining stances or thinking stances tended to be found in group photographs (Photos P07-P09). Boys were also much more likely to be engaging in group science when more than two characters were present in both-gender photographs.

4.2 Mentors

A chi square goodness-of-fit test was run on mentor gender to see if equal proportions of men, women and both men and women were presented as mentors. There was significant differences on the gender of mentors $\chi^2 (2, 82) = 110.15, p < 0.000$. Men were by far the most common mentor, which accounted for 88% of all mentors present on packaging, a frequency 2.6 times the expected frequency. Women mentors and both genders were well below their expected frequencies and made up a marginal 10% and 2% of the total sample respectively.

When a comparative analysis was completed between men and women it was found that men were present 9.0 times more often, which was a significant difference $\chi^2 (1, 80) = 51.20, p < .000$. Additionally, when compared to both genders, men appeared on packaging 36 times more often, which was highly significant $\chi^2 (1, 74) = 66.22, p < .000$. When the same analysis was completed between both genders and women mentors, no significant difference was found, $\chi^2 (1, 10) = 3.6, p = 0.058$, despite women mentors appearing 4.0 times more often. The lack of significance in this case was due to small cell frequencies, which were a result of the extreme underrepresentation of both categories.

Mentors and target absent versus present. Comparative analysis using a chi-square goodness-of-fit test was completed to see if there were equal frequencies of men and women mentors for target-absent toys. When no child was present, masculine mentors were 77 times more likely to be depicted on the package, this was a highly significant difference $\chi^2 (1, 78) = 74.05, p < 0.000$. When the same analysis was completed with target present toys, men were

present 1.75 times more often than women, which was not a significant difference, $\chi^2 (1, 22) = 1.64, p = 0.201$. There was only one toy that presented both masculine and feminine mentors, and the toy did not have a target present. Due to the low frequency no significance test could be completed.

Mentors and number of targets. A comparative analysis was completed using chi-square goodness-of-fit test to determine if equal frequencies of mentor gender were present when both girls and boys were present on the package. Women mentors were present 1.17 times more often than men when both girls and boys were present on the package, this did not constitute a significant difference, $\chi^2 (1, 13) = 0.07, p = 0.782$.

Due to low frequencies of target present toys with mentors on the package, 'boy only' and 'girl only' levels could not be analyzed by mentor gender, quantitatively. A description of the data follows. Toys with only boys on the package were present with a mentor in seven cases. In all cases, the mentor was a man. Comparatively, zero toys with girls only on the package were presented with a masculine mentor, or both men and women mentors. One toy was presented with a single girl and woman mentor.

For women mentors, the frequencies were again too small to do a statistical analysis, but a description of the data will be presented. There were seven toys with a woman mentor. One girls-only photograph had a single target and was the only photograph in that category of girls-only with a feminine mentor. The remaining six had multiple targets of both genders. In four instances or 67% of the time, boys outnumber girls and in two cases or 33% of the time girls outnumbered boys.

For toys depicting masculine mentors, six were found to have multiple targets. Five toys had multiple boys. Three had only boys, which makes up 42% of the photographs in the

masculine mentor and boy-only category. Another two photographs had boys outnumbering girls, which accounted for 33% of the photographs in the masculine mentor and both genders present category. Finally, one had girls outnumbering boys, which accounted for 17% of the photographs in the masculine mentor and both genders present category.

There were no targets present in the one photo depicting mentors of both genders. Furthermore, there were multiple masculine mentors present in six of the 'target absent' photographs (9% of category total) and one 'both boys and girls' photograph (8% of category total). In each case, they were presented as a team of scientists. Six of these occurrences had only masculine figures and one had one woman mentor. Women mentors did not appear in multiples. Lastly, in one instance multiple masculine mentors were present while boys were outnumbering girls.

Mentor and discipline. A weighted ²⁰chi-square goodness-of-fit test was completed on all photographs with a masculine mentor present. This was done to determine if discipline frequencies varied within the masculine mentor variable. It was found that observed frequencies differed significantly from the frequencies expected by chance, $\chi^2(5, 71) = 24.13, p < .000$. The largest discrepancy was found in botany toys, which had significantly more masculine mentors than expected. This is followed by chemistry and physics, which also had more masculine mentors than predicted. Finally, anatomy, engineering and astronomy had significantly fewer mentors than expected.

When comparative analysis were conducted using weighted chi-square goodness-of-fit tests it was found that chemistry was significantly different from all other disciplines except physics in regard to proportion of masculine mentors. More specifically, it was 8.3 times more

²⁰ As each discipline accounts for a different proportion of the overall toy sample, the expected frequencies were weighted in accordance with their expected proportions.

likely to have mentors than astronomy and anatomy, 2.7 times more likely than engineering toys, was 1.8 times more common than physics toys and 1.5 times more common than botany.

Similarly, physics toys were found to be significantly different from astronomy and anatomy, with masculine mentors being 4.7 times more common than both. For more information on masculine mentors by discipline see Table 9.

Table 9 Comparative Analysis of Masculine Mentors by Discipline

Chi-square Goodness of Fit Tests										
	Astronomy		Botany		Anatomy		Engineering		Physics	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Botany	2.57	.109								
Anatomy	0.143	.705	3.77	.052						
Engineering	1.92	.166	0.053	.819	3.00	.083				
Physics	5.56	.018*	0.667	.414	7.12	.008*	1.09	.297		
Chemistry	15.21	.000**	6.43	.011*	17.29	.000**	7.53	.006*	3.10	.078

*significant at the $\alpha=0.050$ level **significant at the $\alpha=0.010$ level

Feminine mentors were present in seven photographs and due to the small frequency a significance test could not be meaningfully applied. An overview of the data is provided. In regard to discipline, two feminine mentors were visible in astronomy toys and five were portrayed in chemistry toys. All of the chemistry toys and one astronomy toy had both genders present. Two chemistry toys had multiple girls present outnumbering a single boy and the remainder had the reverse pattern. One astronomy toy had a single girl target.

Qualitative trends.

Mentor clothing. In boy only photographs, a single child was placed to the left of the mentor and mirrored the mentors clothing and attributes, usually donning glasses, a lab coat and crazy hair (Photo P12). In the one girl only photograph the toddler stood to the right of the mentor and was wearing gender signifying clothing that matched the woman's attire (Photo P13). Interestingly, the trend of science and non-science clothing according to mentor gender was also present when both boys and girls were depicted on the package (Photo P11 & P14).

Illustration 5 Depictions of Masculine Mentors

When the mentor was masculine both the mentor and children were wearing lab coats, in all but one photograph. When the mentor was feminine both the mentor and children were presented in everyday clothing. In all cases, when women mentors were presented alone on the package, they were wearing gender signifying clothing such as pink, dresses, or flowers in their hair (Photos P13 and P14). In the one case where there were mentors of both genders, the feminine mentor matched masculine clothing choices (Photo P15).

When target absent toys were included in the analysis, it was found that 89% of the toys with a masculine mentor featured a traditional lab coat and all of them had crazy Einstein hair (Photo P10). Similarly, 57% of the mentors also wore or had glasses, all of these are typical signifiers used to depict a science. Zero of the women were found to adorn these symbols and no feminine mentors were depicted alone.

Illustration 6 Depictions of Feminine Mentors

Gendered roles. In the seven feminine mentor only photographs, six were the same brand, *Magic School Bus*, where the role model was a teacher and chaperone. The remaining toy was a mother and a toddler. In both cases, the presence of the woman was connected to a social relationship to the children. For example, in the mother-daughter package the title of the toy was *Teach My Toddler, the Solar System* (Photo P13). In the *Magic School Bus* packages, the mentor was always presented behind the wheel of the bus, which elicits images of an adult chaperone on a school field trip (Photo P14). Within this position, it was impossible for her to be active in science activities, since these activities were occurring outside of the bus.

It is worth noting that in each instance where a feminine mentor was withdrawn from the scene, a masculine student who was white and wore glasses was depicted filling the instructional role. The masculine student was depicted in explaining stances directed towards racial minority boys who appeared to be listening. Racial minority girls were depicted off by themselves looking confused. White girls were not depicted in group situations when feminine mentors appeared.

In comparison, all of the masculine mentors were presented in the ‘scientist’ role with no evidence of secondary roles or pre-determined relations to the children (Photos P08-P10). Moreover, in 100% of toys with masculine mentors, the mentors were holding science equipment and presented in an ‘action’ pose. Scientist also tended to be oriented toward boys when both girls and boys appeared with them. There was however, substantially fewer subtle cues regarding statuses between the children when masculine mentors appeared. This was in part because visible minorities were rarely present and children mirrored the scientist’s demographic, dress and level of activity. It is worth noting that all of the feminine and masculine mentors were depicted as white (Photos P10-P14), or an unnatural colouring (Photo P15). So mirrored demographics were exclusionary.

Prominence. In the six *Magic School Bus* photographs the mentor appeared as a very small head behind the wheel of an empty bus found in the background (Photo P14). In each case children were presented outside of the bus in close proximity to science equipment. The mother in the remaining feminine mentor photograph was also placed in the background behind the child but was looking at and leaning over the child in a pose that suggests aiding the child in playing with the toy- possibly instructing her²¹. Finally, the feminine mentor in the mixed gender photograph was also a background character, appeared smaller than the masculine figures and was accompanied by multiple masculine mentors (Photo P15). In comparison, all of the masculine mentor-only photographs had men presented in the foreground, presented larger in size than the typical feminine mentor and the students.

4.3 Gendered Content and Discipline Trends

Gendered Trends. There were many trends in terms of masculine symbolism as well as masculine content. In some cases the amalgamation of symbols discussed previously when placed together made the package appear masculine. The most obvious example of this, would be the annihilation of girls and women on engineering and physics packaging, paired with the absence of other children, and active stance of boys. Within engineering toys, boys were presented 6 times more often than girls. Physics toys, had boys present 14 times more often than girls and there were no photographs where girls were presented alone on the package.

Similarly, when looking at active stance engineering toys had boys active 10 times more often than girls. Physics had boys active 12 times more often than girls. Again these were the highest among all disciplines. Finally, both disciplines had a single target present on the package

²¹ In comparison to masculine instruction stances, which most commonly portrayed pointing; the mother was holding a piece and leaning into the child-not focused on the science but the child. The location of the mother over the child and close to her ear suggests a need for attentiveness over the child's actions- suggesting a relational emphasis.

3-5 times more often than both, or multiples. These were the only disciplines that featured single children more often. In 73-77% of the cases these single children were boys.

Chemistry and anatomy also showed a trend of gender symbols. In both cases, a single overt symbol of masculine audience was used with several gender neutral symbols. For example, chemistry used masculine mentors. It had the greatest number of masculine mentors in the study. Comparatively, this ranged from 1.5-8.3 times the number of mentors in other disciplines.

Similarly, anatomy used masculine targets as its overt symbol. Along with engineering, it had the second highest representation of boys, which was 6 times that of feminine representation. Despite these overt cues, these two disciplines also displayed the most feminine friendly depictions of targets and most inclusive content. In both disciplines, girls were more likely to be active than in other disciplines, and multiple targets usually of both genders were present most often. Content was most commonly discipline specific and un-themed, with neutral coloured promotional content. These disciplines also accounted for all of the feminine catered content, despite the fact that it accounted for less than 10% of themes in each discipline.

Gendered content. Botany and astronomy tended to use gendered content or colouring as their main gender cue. Both of these disciplines had substantially fewer targets on the package than other disciplines. While, botany had a considerable number of masculine mentors, very few of them were depicting a scientist role, in fact, the vast majority were a part of a theme presented on the package, for example an alien, farmer, pirate, or superhero.

The most noteworthy aspect of the botany toy category was its use of masculine themes and colours. The botany content had either neutral themes or strongly masculine themes. Neutral themes were devoid of gendered symbols and most often accompanied by masculine shades.

There was also a large number of masculine themes that were often aggressive, adventure or space related (Photo P16 and P18).

Feminine themes most commonly associated with the botany such as flowers and gardens were almost entirely absent from promotional content. Flowers appeared in two cases, one was positioned as space plants, illustrating space ships, aliens and dark shades (Photo 16). The second was a special type of plant that moved when you touched it, emphasising activity (Photo P03). Neither had esthetic symbols. Similarly, the word garden was avoided in all but two botany toys. In each case, a traditionally masculine theme accompanied the toy. This included commercial farming²² (Photo P17) and a volcano theme with dragons. Finally, botany had one of the largest proportion of toys with dark shades, following astronomy.

Illustration 7 Themes for Botany Toys

Astronomy was similar to botany in its use of masculine colouring, its absence of children on the packaging and absence of feminine themes. It did however have the greatest number of no themed packages which accounted for 85% of all toys in this discipline (Photo P19). Themed toys tended to be vehicle based including spaceships, rovers and in one case a death star from *Star Wars* (Photos P20-P22). There were no feminine themes or neutral themes

Commercial farming as is depicted here, has traditionally been labeled a masculine field despite the fact that families traditionally completed the farming together. It only crossed over into a feminine role when gardening for leisure and family sustenance (Shteir & Lightman, 2006)

present. Astronomy had the greatest representation of dark shades, which is biased in part by the representation of the night sky. However, when accent colours are considered in exclusion of the night sky, it still maintains dark colouring in each case.

Illustration 8 Themes for Astronomy Toys

Feminine toys. Although, there were no uniform trends incorporating feminine symbols within any one discipline, there appeared to be a uniform or standard issue ‘feminine toy.’ Most commonly a feminine product was denoted by multiple girls in active stance on the package. Unlike any other toy designation, multiples outnumber single-representation of targets in this toy category. In these cases boys were not present on the toy and usually two or more girls were present at a time ($\mu=3$).

In non-feminine toys, single boys or both genders were most common and multiple boys were never presented in groups larger than two, unless there were two or more girls also present. In these packages, the presence of multiple boys or boys-only on the package did not mark any visible changes in science themes or colour. However, when multiple girls were present it was marked by an over the top use of pink and purple, or substantive presence of gendered symbols such as flowers, hearts, bows, princesses and purses (Photos P20 and P21).

Illustration 9 Feminine Themed Content

The themes of these toys were also gendered and related to beauty-spa, cosmetics, perfumes, fashion; or domestication— cleaning, baking. The characters were presented in both science and fashion attire, or just fashion attire in all but one photo (Photos P20 and P21). The fashion clothing was often sexual -tight, showed skin or cleavage; and characters regularly held sexual body stances-back arched, or reclining (Photo P21). This was most pronounced in chemistry products as products directed toward girls rarely appeared in other disciplines.

Chapter 5: Summary of Findings

This study set out to examine gender symbolism in the promotional content for science toys and theorized that large numbers of these symbols would be masculine. Specifically, it proposed that more boys would appear on the package than girls, that boys would outnumber girls when both genders appeared and that masculine mentors would be more common than feminine. All of these propositions were confirmed when science toys were looked at as a single group.

This study also proposed that subtle or covert cues such as the shade of toys and absence of a child on the package would denote the toy as masculine. In this case, science toys were dark more often than neutral or light, which matched with trends in masculine gendered toys. Similarly, it was found that science toys that had no child present on the package were more likely to include masculine themes and commonly portrayed masculine shades.

Research on gendered toys suggests that absence of a child on a package was a masculine symbol and presence of a child was most common among feminine toys (Griffiths, 2001). This thesis in part added to this finding. I found that toys using subtle masculine symbolism such as shade, theme and wording, tended to also portray an absence of a child on the package. Toys that were closest to gender neutral such as chemistry and anatomy toys, had the greatest proportion of children present on the package. I also found a third group of toys that were overtly masculine, in terms of masculine characters and themes, which had a greater proportion of targets present and included almost entirely boys. These findings suggest that this phenomenon may be more complex within science toys and more research will be required to tease out the gendered meanings involved.

These findings also lead to the examination of science disciplines as three sub-cultures with their own trend of gendered symbolism. In general, it was found that three distinct trends occurred in the portrayal of masculine symbolism. These groups have been named overtly masculine, covertly masculine and gender neutral with a hint of masculinity. Overtly masculine included engineering and physics, which had a severe overrepresentation of single boys on the packaging and an absence of nearly all feminine symbols. Covertly masculine, depicted no one on the packages but used masculine themes, shades and stereotypical masculine symbols. Covert symbolism was used primarily by disciplines with high feminine representation and historically feminine fields, such as botany and astronomy. This was an unexpected finding.

Finally, gender neutral with a hint of masculinity included anatomy and chemistry. These disciplines were the closest toys to gender neutrality. They had even representation of children on the packages, more neutral shades and fewer stereotypically gendered symbols; but maintained a masculine feel through use of mentors, targets and gendered status symbols that elevated boys over girls. In general, this study highlights the need to address gender-symbolism in science toys, as the most neutral toys are still masculine. These toys need to be investigated more thoroughly in the future and their impact on girls interest or disinterest need to be assessed.

Chapter 6: Conclusions

This study found that science culture included both an overarching culture and three cross-disciplinary sub-cultures. Science culture as a whole, was conveyed through the pairing of masculine symbolism and science symbolism. Due to the presumption of science as objective and by association, science toys as objective, this masculinity was often depicted under the guise of gender neutrality. In other words, the gendering of science was constructed through a wide range of symbols including a large number of covert symbols. These symbols were combined with enough variation that they do not present a uniformly masculine image. The masculinization of science, its presumption of gender neutrality and the cultural implications of these findings will be discussed in the following section.

6.1 Science Culture as a Whole

Overall, the findings of this study shows a trend toward the masculinization of promotional material for science toys as a group. For example, a single boy appeared on packaging more often than single and multiple girls or both genders. Boys commonly outnumbered girls when both genders were present. Masculine mentors accounted for 88% of all adults that appeared in promotional content. Finally, a dark shade was used in 72% of all packaging-which matched the colour schemes of boy's toys. This rate increased to 86% when no-target was present within the promotional content.

It was found that at least one symbol-category, within each discipline, was used consistently to denote the toy as conforming to masculine culture. For example, chemistry uses masculine mentors to depict the toy as masculine. Additionally, it was found that a combination of multiple symbols were used to reinforce the masculinity of more covert cues. For example, astronomy uses target absent, masculine themes and masculine colours.

It is not clear whether this masculinization is a result of science culture itself being masculine or toys conforming to the industry ideal of making ‘gender neutral’ toys appear masculine (Jacob & Geer, 2006). The latter is a common move in the toy industry, which hinges on the idea that boys will not play with toys intended for girls, but that the reverse is untrue (Jacob & Geer, 2006). In such instances, it is more risk-averse to masculinize any content that is not exclusively marketed to girls.

Science toys are typically marketed as ‘gender neutral’ and explicitly separated from gendered toys, within the toy store. The rationale behind this, is the need to create a divide between gendered stereotypes and educational pursuits. Thus, I questioned whether the ‘gender neutral equals masculinity’ idiom would still apply. Within this study, the more gender-neutral a discipline appeared in terms of overt symbolism²³, the more it used subtle stereotypically masculine symbols relating to content or shade.

Therefore, science culture tended to form three camps: overtly masculine, covertly masculine and gender-neutral with a hint of masculinity. Due to the absence of feminine symbols in science toys as a whole, and the masculinization of presumably neutral toys, the conceptual categories of ‘masculine’ and ‘gender-neutral’ became slightly blurred. Moreover, the categories of femininity and true ‘gender neutrality’ were not employed in any uniform way.²⁴

The idea of ‘gender neutrality’ being inherently masculine is a well-studied phenomena both within Canadian society and within science. Both domains maintain a patriarchal power structure, where men hold a disproportionate amount of power positions. Thus, there is an over-

²³ Overt symbolism would refer to gender of targets or mentors or statements of gender like ‘Chemistry kit for girls.’

²⁴ There were certainly toys that fell into the truly gender neutral category and the feminine categories but they were an exception rather than the rule, they were also dispersed across multiple disciplines and did not form any distinct trends relating to a specific field or group of fields.

representation of masculine viewpoints, accommodation to masculine preferences and an exultation of masculine behaviours and interests.

In science, this is proliferated by the principal of objectivity, which presumes a person can separate their personhood from their work. As it is physically impossible to escape embodiment, what tends to happen is a separation of label rather than a separation of intellect. Largely, this practice covertly rebrands expressions of masculinities as ‘neutral’ or status quo. According to Keller (1987), the presumption of ‘gender neutrality’ is used to perpetuate gendered oppression in science contexts. This is done through the reproduction of a gendered hierarchy. The culture and system are adapted to masculinized ideals that fail to ‘fit’ the identities and abilities of girls and women. This reproduction is done in part, through the fabrication and transfer of gendered-science symbols under the guise of ‘gender neutrality.’ This neutrality directs the blame for the problem of ‘fit’ away from science and onto girls themselves; thus, reproducing inequity of structure and symbols.

This study contextualizes the trend of masculinity being used as the status quo or the not so neutral gender-neutral. It does so, based on three themes: 1) the gap between how science toys are typically categorized or portrayed overtly and the accumulation of all gendered symbols; 2) the magnitude of conformity to masculine standards, and 3) symbols of feminine subordination and masculine domination.

As discussed above, it is unclear whether the standardization of masculinity in science toys is a part of science culture, commercial culture or an amalgamation of the two. Both domains fall under Canadian culture, which reinforces the idea of masculinity as both prized and dominant and evokes the idea of men practicing femininity as ‘giving up their power’ or

conforming to subordinate masculinities. Thus, being accused of, mistaken for, or showing any signs of femininity is often seen as extremely undesirable for men.

The protection of masculine privilege was supported in this study. For example, the most common symbol-type used to signify masculinity with each discipline, had nearly uniform adherence within the toy-category. Additionally, symbols that were constructed as distinctly feminine were not used consistently across any disciplinary category. Subtle feminine symbols, such as pastel shades, girls outnumbering boys and feminine content were severely underrepresented in the sample as a whole and were never mixed with masculine symbols. These symbols appeared on products targeted specifically for girls, with an over-the-top use of feminine symbolism. These packages were never presented with the absence of a girl on the promotional materials.

Advertisers use children on promotional content to provide an overt symbol of the intended target audience. As previously found in gendered toys and confirmed in this study, girls were regularly placed on packages to denote the medium as a toy intended for girls. Boys were almost never presented on gendered-toy packages as all content that was not explicitly designated for girls was presumed to be suited to the masculine domain. This was emerged within disciplines adhering to a covertly masculine subculture and boy's toys within this study. These findings were concurrent with other studies on science content and gendered toys.

A novel finding, was that the presence of a child on the package was not an inherently feminine symbol, as is the case among gender toys (Griffiths, 2001). Instead, it was an overt symbol designating the gender of the target audience the toy was intended for. In the majority of cases, these representations were masculine, or both genders. This differed significantly by discipline and will be discussed in greater detail in the coming pages.

When neither, the absence of a target or presence of a single target were employed to signify the gender of a toy, several other cues were used to establish a masculine norm. These other subtle cues gained gender meanings through the relational binaries it established within toy photographs. In these cases how each child ‘did gender’ transferred knowledge about who should ‘do science’, or the demographics of the default target audience for the toy.

Depictions of youth ‘doing gender’. According to Butler (1990) and Connell (1995), symbols are often constructed in binary terms positioning gender as an opposition between two and only two groups. As previously discussed, new domains become gendered by relating a new theme to one or more concepts attributed to a gender category. Then these symbols inherit the oppositional relationship between gendered groups. In this study, several key binaries were depicted within science photographs, these binaries served to enforce subordination or alienation of girls or emphasise their traditional femininity, generally presumed complementary to hegemonic masculinity.

Several symbols were used to depict girls as ‘out of place,’ mentally inferior or inactive, whereas, simultaneously positioning boys as experts. The first way this was done was through the comfortable versus uncomfortable binary, then the expert versus novice binary, followed by a recreational science versus serious science binary.

Girls were often depicted with negative emotions such as worry, uneasiness, apprehension or fear. The ‘scary’ depiction drudges up stereotypical themes of girls as fragile, emotional and in need of protection. According to Henning (1999), science has often been constructed as too much for women’s fragile bodies and overly emotional minds. Throughout history, a number of psychological and physical ailments have been attributed to women expanding their minds too quickly. According to Freud, Benjamin and Simmel these same

concerns do not apply to men whom have a naturally armoured consciousness to protect them against over-stimulation and the excessive energies of the mechanical world (Keller, 1985). Essentially, the intellect and increased capacity for reason possessed by men protected them. The propensity for emotionality and subjective reasoning possessed by women made them susceptible (Simmel, 1964).

Although much has changed since these theories were created, this sentiment still persists in scientific culture²⁵. For example, in 2005, Lawrence Summers a renowned physicist and President of Harvard University, described science as something ‘better suited for men,’ stating that they had the raw intellectual talent needed to excel in the harsh competitive environment of academia (Summers, 2005). Similarly, a major science journal made national news when a reviewer suggested that a woman find a masculine co-author to ‘lend credibility to her work’ (Times, 2014).

The idea that science is too much for girls, but not for boys was depicted regularly within the photographs. Boys were never found to be displaying negative emotions or any emotion outside of self-assurance and intrigue. Furthermore, each time a girl was presented as scared, she was accompanied by a boy that was either unafraid, explaining the phenomenon or in direct control of the equipment she was apprehensive about.

According to Judith Williamson (1978; 1994), advertisements rely on “a transfer of meanings appropriated from various cultural ‘referent systems’”(p. 7). These systems include meanings from popular cultural and scientific culture, which are transferred on to new mediums,

²⁵ While the statements made by these men are not representative of the current discourse around science and women, these ideas entered and greatly influenced the public discourse in a monumental way. Similar but less stark views are not an usual occurrence in current times. In many ways these sentiments have been maintained, and the obvious connection to oppression has become more covert (Bevan & Learmonth, 2013). These sorts of covert beliefs can often be uncovered in material culture, through the investigation of symbolism, as is suggested in this study (Baxter, 2005).

such as toys, by propagating an identifiable symbol related to established stereotypes. In this case, the symbol of 'uneasiness' or 'discomfort' for girls, constructs science as something that may be too much for them. Additionally, the use of 'comfort' for boys paints science as a common stomping ground. This transfers a meaning of 'fit' or lack thereof, with the toy and with science as a whole.

On a similar note, the binary of expert versus novice or instructor versus student were often found within the photographs. Girls regularly held an 'I don't know' stance, surprised facial expression or a glazed over look with a posed smile. All of these symbols have been attributed to a lack of knowledge or novice hierarchical stance within anthropological literature. Again, these images play into the idea of inferior intellect; as being surprised assumes no prior knowledge of a phenomenon and 'I don't know' or posed smiles assumes a lack of awareness of one's surroundings or difficulty understanding the phenomenon as it unravels. These expressions signified girls as novices or students, when boys were teaching them. Contrarily, boys were never portrayed in an unknowing way and were positioned as experts, holding thinking or explaining stances.

This trend was also found among mentors. Masculine mentors were positioned in teaching stances and women mentors were position in caregiving stances or chaperone roles for example a mentor sitting inside the bus while the children do science outside. In the case of six feminine mentors, a white boy with glasses took on the role of teaching other students while the mentor was distanced.

Both girls and women mentors were also less likely to be touching equipment. In all but one photo, the feminine mentor had no contact with science equipment, again she was removed from the situation. Girls were also commonly portrayed outside of the science situation, looking

at equipment but not touching it or touching it lightly but not manipulating it. Only one photo out of the 400 toy photographs depicted a girl in a teaching stance.

Masculine mentors were holding equipment in every single photo and boys commonly held equipment as well. Men were always placed in the foreground, at the same level as children and in a teaching stance. In contrast, women and girls were regularly portrayed in the background rather than foreground.

These relational connotations set up a hierarchy in terms of expertise. Goffman's theory of 'function ranking' applied to such findings. Essentially, he found that when men and women were presented in an advertisement together, the man would be considered the 'executor' of the task being completed and the woman would play a support role (Goffman, 1979). This was certainly the case in this study. Little boys were poised as the executor over both girls and feminine mentors. The only photo with a feminine mentor as an executor had no boy present. Similarly, masculine mentors were also the executors in every photo regardless of who was portrayed in it.

It also touches on Goffman's theory of the 'feminine touch' where woman commonly were found to lightly touch objects in advertisements, but not hold or manipulate them. Meanwhile, men would grasp, hold, manipulate objects or take command of equipment showing domination of the domain. These symbols reiterate a hierarchical relationship where boys are portrayed as the 'rightful' audience for such tasks. Another theme found in the literature was the 'licensed withdrawal,' where a feminine character is withdrawn from the object of importance. This occurred both in terms of mentors being withdrawn from the teaching environment and girls looking away from the scene or portraying a distant look or unattached look with a posed smile.

With the theory, the presence of a male executor, provides the women or girl with presumed safety so that she may disengage from the situation.

Finally, ‘relative size’ as described by Goffman (1979), was also illustrated within this thesis, as women were displayed as smaller, farther away, off to one side, or outside of the instructional or experimental situation. According to his theory the size or prominence of a character depicts their relationship in terms of perceived power. Larger images, characters centred in the scene and people occupying the foreground of a photo were considered more important or powerful. Characters found off centre, smaller and further away were considered as less powerful. All of these elements reintegrate a gender hierarchical relation where boys and men are displayed as the primary object of interest. The continual portrayal of women, and girls as off centre, background, smaller or removed from the action in the scene points to the continued masculine hegemony of scientific content.

The final binary displayed in the photographs was that of recreational science and serious science. Women mentors were always depicted in recreational science environments, outside of a school or lab. The *Magic School Bus* illustrated field-trips and field study and the *Teach My Toddler* toy presented an at home recreational activity. Thus the contexts of these series illustrate women mentors as doing science for leisure, instead of establishing their expert role.

In all cases, women were presented in casual non-science related clothing and the children were wearing similar garments. There was an obvious absence of science signifiers such as glasses, pens, stethoscope, magnifying glass etc. In contrast, masculine mentors were presented almost exclusively in lab coats (the exception being three Einstein characters who wore his historic sweater-pant outfit). The majority of them adorned glasses, pens and science

related equipment such as beakers. They were more commonly depicted indoors often in a lab setting.

In North American culture, the lab coat is used to signify specialization, or an elevation of status based on knowledge (Shteir & Lightman, 2006). It is also attire only worn in employment settings that situates the wearer as an expert in the public realm. Science instruments imply the same meaning (but are not recognized as universally as the lab coat symbol). Glasses are one of the most recognizable symbols for intelligence and ‘old white man’ is a trope representing wisdom (Nisbet, 2002).

In contrast, everyday clothes symbolizes an ordinariness or lack of elevated status (Shteir & Lightman, 2006). These clothes represent non-professional status, which places the character either in the personal realm (mother and daughter in the home), or a recreational-public realm- both of which positions the mentor as a caretaker or chaperone. Both the caretaker role and the non-scientific dress are part of a long standing set of visual symbols used to depict women as subordinate knowledge producers. Casual clothing in science study has historically been used to denote casual knowledge and a romantic view of nature lacking the rigor or rationality of masculine scientific study (Shteir & Lightman, 2006).

These symbols first appeared in the 1800s when clothing distinctions were used to differentiate the accomplishments of amateur women involved in recreational nature study, from distinguished masculine academics (Tolley, 2003). These symbols were built on to attack feminine competency in later years. In the 1920s science societies in North America led a campaign against the appropriateness of women as science teachers. The feared feminization of science was said to make boys achievement scores low. They ran a series of editorials depicting women as nothing more than amateur hobbyist in everyday clothing teaching incorrect,

unintelligent or romanticized science (Tolley, 2003). Following these ads, women were rarely depicted in scientist attire or science teaching roles in popular media.

More recent research has found that reinforcing the association between women and ‘recreational science’ both diminished the competency attributed to the character and moved the character into the role of sex-object for masculine viewing audiences (O’Donohoe, 1993). In contrast, masculine mentors were typically perceived by boys as a character one would aspire to and by girls as something they would never aspire to. Nearly 50 years of ‘draw-a-scientist’ studies have found that the image of an old white man with glasses, alienates girls and makes them think science isn’t for them (Finson, 2002). When they are exposed to women mentors these attitudes change drastically. As commonly put, you can’t be what you can’t see.

This combination of these findings again point to science as something that is constructed ‘for boys’ as the underrepresentation of feminine mentors, position boys as the assumed-audience. The devaluation of women’s expertise through clothing, size and inactivity also protects masculine privilege. The absence of feminine mentors also displays an absence of concern for girl’s achievement and involvement, which signifies again a patriarchal culture²⁶ and masculine hegemony within science as a whole.

6.2 Science as Multiple Cultures

The analysis of gendered symbols in science toys revealed that science is not an entirely uniform concept, despite being described in uniform terms in science and popular culture. As previously alluded to, each discipline had a separate set of gendered norms that symbolized a

²⁶ The moral panic that occurs surround boys lower science scores, come into fashion about every twenty years. This has been the case since the 1920s when gender segregated schools were abolished. When these outcries occur communities demand changes to programs, news articles articulate how boys are being ‘left out’ of science and feminism is typically blamed for breaking the system. This phenomenon does not happen for girls, there is no public outcry when girls score lower, similarly the system is not perceived as broken by large number of the general public when it fails to turn out girls (Ford, 1993).

masculinization or feminization of the given field. Disciplines formed three distinct groups that differed based on representation in adult science, youth uptake and commercial culture- i.e. salibility. These sub-cultures were composed of physics and engineering (overtly masculine); chemistry and anatomy (gender neutral with a hint of masculinity); and botany and astronomy (covertly masculine).

Overtly masculine culture. Engineering and physics are masculine dominated fields as women make up less than a tenth of scientists working in these domains (NSERC, 2010). These disciplines both fall under the branch of ‘hard science,’ which historically has been constructed as strongly masculine. For example, engineering toys share several symbols and themes with boy’s toys in terms of construction and demolition, which are depicted as stereotypical masculine activities. Physics conjures images of Einstein, the physical archetype for nearly every science mentor and depiction of the masculine role for future scientists. Physics is highly related to abstract theory or that masculinized raw analytical talent, discussed above. Engineering deals with heavy machinery, embodying ideas of physical strength and endurance attributed to masculinity but not femininity.

The most common symbols between the disciplines were the use of masculine targets, active stance for boys and presence of a single child versus multiple. They differed in the number of masculine mentors. The important factors that bind these disciplines into a category is the severe underrepresentation of girls on the package. For example boys appeared 6 times more often in engineering, 14 times more often in physics. As well as the lack of other characters on the package, 73-77% depicted a single boy and the magnitude of representation that occurs when any other symbol was used to exhibit masculinity.

When I examined toys intended for boys, I found that masculine symbols were used in a nearly uniform fashion, recall that target-absence was used in 86% of photographs. This trend was mimicked in engineering and physics. Basically, each time a common symbol was used, the magnitude of its deployment in the discipline was massive. This was not the case with other disciplines that had more moderate proportions or a few main symbols. This subculture also shied away from tokenism-placing a girl on the package for equity, gender neutral signifiers-lighter colouring and neutral content themes or more covert cues like using ‘target-absence’ packaging. Finally, the need to put only one child on the package could signify that the reinforcement of masculinity, which occurs when multiple single-gender targets are placed in a photo, was not required in this domain. The adult culture is recognized as highly masculine and the images, themes and topic areas presented in the toys already adhered to masculine norms of the greater Canadian culture.

The perseverance of the magnitude of masculine symbolism in this sub-culture congers ideas of hegemonic masculinity, where an assumed male dominance is depicted and reproduced through advertisements. The subordination of women and girls is singled by their symbolic annihilation from these toys. According to Tuchman (1978) the omission of women/girls facilitates their oppression by rendering them invisible. Research has also found that the greater a group's absence the greater their oppression. Finally, Bourdieu (1977; 1990) discussed omission as a form of subtle violence, intended to discount the legitimacy of an underrepresented identity within the given domain.

The overt masculinization of this sub-culture has been related to anti-feminine science cultures in the adult world. Hewlett et al. (2008) found that engineering and physics belonged to a set of macho cultures called hard hat and geek. Hardhat culture, related to engineering and was

a highly masculinized environment, where women were perceived as sex-objects instead of co-workers. It was signified by overt sexism, derogatory and sexual language, emphasis on building or breaking things, risk-taking and physical strength. Geek culture focused on indoor activities, technical knowledge and abstract theory; with the assumption of masculine superiority in these domains (commonly related to math, computer science and physics). This culture included overt discrimination and exclusion of women, with the sentiment that they failed to have the mental prowess of men.

Both cultures were built on the domination of men over the field and they included an overt exaggerated masculinity and an absence of concern for equity in general. Neither hard hat nor geek culture included a gender hierarchy though, as men were presumed to dominate these disciplines and women were a rarity. These cultures line up fairly well with the overt-masculine sub-culture defined in this study. The absence of girls, women and feminine symbols, as well as the overt symbolism of masculine culture support this theory. Also the absence of mentors and multiple characters shows that gender hierarchies were not required to protect the masculine status of these disciplines.

Gender neutral with a hint of masculinity. Chemistry and anatomy are what I call contested field, in terms of science culture. Both fields have a considerable amount of women practicing science within them, making nearly equal numbers. Historically, women have participated within each field but held marginalized positions (Shteir & Lightman, 2006). Anatomy has historical ties to a strong gender hierarchy where women are constructed as subordinate caretakers instead of decision makers, i.e. nurses instead of doctors. Similarly, women historically participated in alchemy and homeopathy, which were predecessors to chemistry (Shteir & Lightman, 2006). When alchemy gave way to chemistry the new discipline

was rebranded as masculine. This new discipline rejected the previous notions of spirituality and subjectivity which were traditional feminine practices and then condemned feminine participation. Each discipline has made considerable progress in terms of the representation of women, but both still maintain strong gender hierarchies. As women tend to occupy lower status positions and men in higher ranked positions there is a masculinization of these scientist roles in media.

Within the study, these disciplines both portrayed equal representation of child gender, use of masculine or targets mentors and images depicting gender hierarchical status, such as relational roles. The presence of single boys on the package differed between them. The factors that bind this sub-culture together are a) the presence of overt and covert gender neutral symbols such as even representation of children, greater frequency of neutral package shades, fewer stereotypically masculine themes; and b) the masculinization of mentors and high status positions.

Chemistry had the highest number of mentors of which nearly all of them were men. Anatomy had nearly equal mentors, but women mentors were deemphasised, i.e. not participating in science or instruction, more trivialized roles. In this discipline, status symbols were used regularly with boys wearing surgeon outfits while girls wore doctor's outfits, or boys being doctors while girls were nurses. Anatomy also had the third highest ratio of single boys on the package, which was still outnumbered by even representation.

In this sub-discipline, several of the tests for specific symbols came up nearly gender neutral with chemistry having nearly equal representation in several symbols. However, for each discipline the gendered hierarchy was emphasized or reiterated, this move again protects the

masculine claim to such domains. It may also be a residual from toy culture poisoning gender neutrality as masculine.

This culture has been linked to ‘lab coat’ culture in adult science contexts. This culture included both genders, indoor tedious work with long hours. There was minimal overt discrimination, but systemic barriers to progression lead to a gendered hierarchy where men out ranked women. Lab coat mapped onto gender-neutral culture-with a hint of masculinity, fairly well. These toys had an abundance of ‘lab coat imagery,’ were positioned as indoor, detail oriented activities. They also had the greatest presence of both genders on the packages, while also having the greatest number of masculine mentors (chemistry) and second greatest number of masculine targets (anatomy). The presence of the mentor or target establishes the hierarchy, but the presence of and active stance of both genders depicts a more feminine friendly environment.

Covertly masculine culture. Botany and ecology are traditionally feminine disciplines where women represent the majority of scientists within these fields (NSERC, 2010). Gardening- the main informal science activity, is a traditionally feminine hobby, in terms of gender roles. Finally, Mother Nature, as well as flowers and fauna form stereotypical symbols of femininity in both science and popular culture (Toumey, 1996; Shteir & Lightman, 2006).

Astronomy has historically has been practiced by both genders, despite having more men than women in the discipline (StatsCan, 2012). In terms of informal and youth science- it is predominantly practiced by girls, who prefer activities that allow them to concentrate for long periods of time and require memorization (Salmi, 2007; NSERC, 2015b). These activities have been chosen significantly less often by boys who prefer more action oriented tasks, with shorter attentional requirements. Therefore, in the realm of youth science it is commonly portrayed as a more feminine discipline, despite a more masculine adult culture.

The symbols employed most often in both disciplines were absence of target and the use of another subtle masculine symbol such as shade, content, or mentor. They differed on number of masculine mentors and magnitude of difference in shade. The important factor that binds this category is the absence of feminine symbols, presence of covert masculine symbols and the reluctance to identify a main target audience.

It is worth noting that botany had the greatest number and greatest diversity of stereotypical masculine themes presented in one discipline. It also actively avoided association with common cultural meanings that painted the discipline as feminine (no flowers, the word garden was avoided etc.). Astronomy also had a complete absence of feminine themes and covert symbols. Rather than content it mainly used shade to disclose its masculine stance.

The active avoidance of identifying an audience, while subtly presenting masculine symbols signifies a covert masculinity. By nature covert symbols apply an influence that is taken up unconsciously but rarely recognized at first glance. The masculinization of this discipline is likely the result of both commercial culture and science culture. The existence of the 'problem of fit' between girls and science may make targeting a feminine audience overtly unprofitable, as they may not provide a large enough sales base to create increasing capital. Using feminine symbols violates the assumption of masculine oriented 'gender neutrality' and would lead to a loss of the masculine audience. Using more overt masculine symbolism such as boy-targets, would likely alienate their primary audience. As these disciplines are not using overt cues and have feminine depictions in youth science or popular culture a kind of over-compensation is likely in order to overcome these relations and be perceived as masculine.

This trend has been found elsewhere in the study- toys intended for girls employed the over use of stereotypical content to overcome depictions of hard science as for boys. However,

since it targeted girls it was not bound by the same rules of masculine neutrality, employed in the toy industry. Unlike the other sub-cultures covert masculinity did not have an adult-science culture category by which it could be mapped onto. The emphasis for the other categories were overt sexism, masculine hierarchical relations, indoor activities or high-risk, action packed outdoor activity. Botany, astronomy do not fit any of these domains. They also do not fit the overall tone of the above culture, which focuses on the barriers of masculine science cultures.

Impact of masculine cultures. Research on science content found that girls interpret both masculine and gender neutral content as ‘for boys’. As all of the sub-cultures described above would fall under these descriptions, the impact of these symbols may not be overly positive. When girls are presented with media adorned with masculine symbols they have been found to be visibly less engaged, less likely to continue the task and more likely to describe it as boring, hard and not for them. Girls are less likely to enroll in programs using these symbols and less likely to do well in academic activities that endorse these images.

As previously discussed, research on developing sustained science interest requires the toy to peak the situational interest of a child, create an emotional connection through an authentic experience and be reinforced through social encouragement. The perception of science toys as masculine would violate the condition of ‘matching interest’ in step one. Masculine symbolism creates a mismatch between the knowledge bases and non-science experiences, identities and beliefs of girls, meaning it would fail step two. Finally, parents and peers were found to surveillance youth interests. Parents have been found to be less likely to buy science toys for girls (Bleeker & Jacobs, 2004) and less likely to encourage their science interests (Tenenbaum & Leaper, 2003).

Research on the purchase of museum paraphernalia, suggests that masculine symbols discourage parental endorsement, but feminine symbols reverse this effect (Bell et al., 2009). In fact, feminine symbols changed parent-child relations in regard to science encouragement. Many of the handicapping behaviours completed by parents and peers disappear when the content no longer appeared 'mismatched' to feminine identity. Finally, according to Canada's top science students the three most crucial influences in their science interest were 1) parents support and encouragement, 2) shared interest with peers, and 3) science toys and hobby materials. Masculine symbols have been found to act as a barrier in each of these areas, with the exception of science toys, which has yet to be studied.

Although the current study can't draw a conclusion regarding children perception of science toys, it can confirm that these toys are highly masculine. Hundreds of other studies on science content found that masculine symbols were perceived poorly by girls and create a feeling science and science media 'wasn't for them.' Finally, Clarke and Clarke (1950), Powell-Hopson & Hopson, (1988) and Holmes (2003) found that toys with symbols that did not match a child demographics lead the child to form an 'othering' identity. This identity resulted in unrepresented groups losing confidence in their abilities and feeling vulnerable for pursuing activities that 'aren't for them,' furthermore these toys fostered feelings of devaluation, not just within the specific domain that the toy represented, but in life itself. These toys taught children that toys and life were not constructed 'for them.'

In short, the absence of feminine or truly gender neutral symbols found in this study has grave implications for the development of science interest in girls. These symbols reproduce a form of hegemonic masculinity where the elevated societal role of knowledge producer is privileged to boys and men over girls and women. As toys are used to socialize gender, societal

location and appropriateness of adult roles; the masculinization of this domain is problematic. It has the potential to teach girls at an impressionable age, that one of the most employable, financially stable and impactful careers in the world isn't for them.

6.3 Limitations

In general, there were issues with sample sizes. Some disciplines, such as physics, just had substantially fewer toys. Other disciplines had used 'absence of child' symbolism to such an extent that analyzing the demographics of children on the remaining packages was not statistically meaningful. Furthermore, the representation of women and girls was so severe at times that it violated assumptions for cell size. Thus, even when the overall sample size was large, feminine representation within it was so small that it couldn't be measured statistically. This greatly limited the analysis. In these cases the findings would have benefited from a more thorough qualitative analysis, which was beyond the scope of this paper.

For the presence versus absence analysis, neither set of expected values was optimal for analyzing the differences between the categories. Completing a chi-square goodness-of-fit test with assumptions of equal frequencies split the differences in half. Therefore, a frequency of absent for example had to be nearly double that of present in order to be deemed different. On occasion it was evident that the frequencies did in fact differ but just barely missed the 'bar' for the expected values. This expected value was not theoretically meaningful, but rather a benchmark that I created and at times failed to be sensitive enough to identify these differences. This problem was amplified by the presence of smaller sample sizes in several analysis.

Likewise, the gendered toy ratios were also problematic. The ratio for girls was 60-40 making it much easier to confirm feminine signifiers than masculine, which were 86-14. Therefore, a toy category could have significantly more absence targets than present, but still fail

to match masculine standards, as was the case with astronomy. If the same magnitude were found in the other direction it would have been confirmed as feminine. Therefore, future research should find a better standard for ‘expected values,’ or better yet a large enough sample size to complete cross-tabulations without eliminating disciplines.

6.4 Future Considerations

Future research efforts should look at girl’s perceptions of symbols in science toys. Ideally this would include both an interview process where they explain what ‘doesn’t fit’ and their perception of toys as masculine or feminine, along with a content analysis of symbols within the toys. This would allow for a gendered scale to be created, it would also allow the gender perceptions of colour schemes be evaluated and classified in a more valid and useful way. This was too large a scope for the current project, but would certainly be an appropriate follow up study.

Another important area that requires further investigation is the adult science culture of botany and astronomy. All of the research I found on this topic were too discipline specific to provided valuable comparison to the findings within this study. A greater investigation into non-masculine dominated science culture in general would provide valuable insight into content producers who are producing toys that counter the masculine norm of science as a whole.

Researching the decision process of the people creating promotional content and their use of gendered symbols would be especially eye opening. I was unable to pinpoint whether the masculinization of the toy content was due to science culture or commercial culture, or both- and I felt I did not know enough about this intersection to theorize. Unfortunately there is not a lot of accessible research on this matter (most of it was behind heavy pay-walls).

A final consideration, is the need for future research on informal science to include analyses on disciplines or sub cultures. By collapsing science disciplines into one category it hides the existence of progress toward equity made in fields like chemistry. For example, boys outnumber girls 3-1 in representation, but no difference exists in chemistry. It also skews the finding significantly. If science is being measured as a uniform culture, the number of cases from each discipline would change the results drastically. It could lead to either a significant or insignificant effect or a change in direction of the phenomenon measured.

6.5 Uses for Research

As a strong believer in praxis, it is important to me that my research be used to achieve some magnitude of change, in terms of feminine representation. This research would be most suited for program managers of informal science organizations or science toy designers. While some of the findings in this paper seem self-evident, such as the gender of a child on the package being a gender symbol, others are much more subtle. Symbols, such as looking at the camera versus looking at the equipment, or roles in group dynamics are rather novel for the science toy realm.

Toy and content designers in the ISL community should take into account these subtle cues and try to present a more even representation. Specifically, if some of the feminine characters looked at science equipment and made excited expressions, rather than being a model to check an equity box this could improve the assumption of science as ‘for boys.’ More importantly, content designers need to start portraying feminine mentors in the role of scientist and in an instructing rather than a parenting position. Removing ‘I don’t know’ or expressions of uneasiness, could also help girls feel more at home in science. On a more ambitious note, have girls in expert roles and explaining poses appearing self-confident, could do a lot for the image

of girls as scientifically competent. In my opinion, all of these adaptations would provide meaningful changes to science culture and scientific endeavours for girls.

Finally, having feminine content that covered topic areas other than beauty and domestication, could go a long way to bridging the gender gap. In general, re-affirming emphasised femininity or traditional gender roles in science media does not tackle the greater issue of feminine underrepresentation, especially if it is presented as the only option. Given that science is traditionally constructed as a violation of feminine roles, girls who do not ascribe to these roles may make up the majority of science-enthused girls. Hyper-feminine content may be a deterrent for all other forms of femininities. Perhaps giving girls an option outside of beautician or aggressive space invader could go a long way.

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Appendix A

Code Book-Short Form

Category	Codes	Definition
1. Discipline	1 Astronomy	<p>The branch of science which deals with celestial objects, space, and the physical universe as a whole. (oxford, 2015)</p> <ul style="list-style-type: none"> - includes representations of non-manmade objects exterior to earth - the examination of these objects - taxonomy regarding these objects
	2 Botany	<p>The scientific study of the physiology, structure, genetics, ecology, distribution, classification, and economic importance of plants. (oxford, 2015)</p> <ul style="list-style-type: none"> - includes representation of plants as main element within the toy - gardening, composting, using of plant parts to create other things - taxonomy of plants
	3 Anatomy/Ecology	<p>The scientific study of the physiology, structure, genetics, ecology, distribution, classification, and economic importance of animals, humans, and insects.</p> <ul style="list-style-type: none"> - includes representations of animals etc. in anatomical form or in interaction with its natural environment - dissection, taxonomy, animals within an ecosystem
	4 Engineering	<p>The branch of science and technology concerned with the design, building, and use of engines, machines, and structures.</p>

	5 Physics	The branch of science concerned with the nature and properties of matter and energy. Emphasis on motion, and various forces. - measuring force, velocity, motion etc. - has the word 'physics' on the promotional content.
2. Target		
Target- photo or charterer representation of a human child, adolescent or teen.	0 No target	Absence of target (still permits appearance of adults, and non-human charterers)
	1 Female target	Target present with female signifiers
	2 Male target	Target present with male signifiers
	3 Male and female targets	Multiple targets present - one or more with male signifiers, one or more with female signifiers
3.GActive		
	0 n/a	No girl present
	1 Girl active	Touching, manipulating, using, holding equipment
	2 Girl passive	Absence of the above actions
4.BActive		
	0 n/a	No boy present
	1 Boy active	Touching, manipulating, using, holding equipment
	2 Boy passive	Absence of the above actions
5.Outnumbered		
	0 n/a	
	1 Boys outnumber girls	
	2 Girls outnumber boys	
6.Mentors		
A photo or charterer of a human adult or a personified animal who is posing as an expert, teacher, scientist etc.	0 n/a	- no mentor present
	1 Male mentor	Mentor with male signifiers
	2 Female mentor	Mentor with female signifiers
	3 Unknown	Mentor with ambiguous signifiers
7. Prominence		
	0 n/a	-one gender is larger than the

		other
	1 Boys more prominent	-one gender is closer to the camera point (either centred, or foreground) than the other
	2 Girls more prominent	- closer to equipment or mentors
	3 Equal prominence	
8. Masculine Content	Ozcs and goos, prank related, sports, aggression, vehicle related, strength related	
9. Feminine Content	Domestic, aesthetics, relational	
11. Shade		
	1.0 Neutral	Most prominent colour, if there are several equally prominent – each with different shades, than the one in the centre of the photo
	1.1 Dark	
	1.2 Light/pastel	