# NEUROLOGIZING THE ADOLESCENT: AN EXPLORATION OF FACTICITY WITHIN THE SCIENTIFIC STUDY OF ADOLESCENCE

**Janelle Caetano**

Thesis Submitted to the University of Ottawa
in Partial Fulfillment of the Requirements for the
Degree of Master of Arts

Department of Criminology
Faculty of Social Sciences
University of Ottawa

# ABSTRACT

Neuroscience has become, more and more, a tool used to explain and define human behaviour. This neurologizing of behaviour not only occurs in scientific studies, but also in criminal law where brain scans are used to determine culpability. One specific group of people that has been subject to this neurologization is adolescents. Recent scientific research has studied brain development in order to explain adolescent behaviour. In addition, neurological development has been used to explain the differing treatment of adolescents versus adults in the criminal justice system. To explore this neurologization of adolescence, this thesis focuses on one research paper produced from a team of prominent researchers in the field of adolescent psychology. This exploration adopts a relational view of science from Actor Network Theory. The goal of the analysis is to explore the facticity of statements produced in science through the neurologization of adolescence. It is important to consider the scientific process of fact production in order to understand the way in which these neuroscience explanations and definitions of behaviour hold together so strongly. I explore how the neurologization of adolescence from one research paper builds and maintains connections through multiple movements, producing a neurologized adolescent entity that forms part of reality. Through each movement, the neurologized adolescent grows longer and stronger in its connections to social, material, and cultural actors, thus ensuring that it holds together as fact.

# ACKNOWLEDGEMENTS

First, I must thank my supervisor, Martin Dufresne, for supporting me throughout this process. I was encouraged, in my undergraduate degree, to pursue research that combined my interest in both the sciences and humanities. This interest brought me to the University of Ottawa and to working with Martin. This is a decision I never regretted as he engaged me in thoughtful and provocative conversation, and provided me with the guidance I required to successfully complete this thesis. I am very grateful to have had a professional, interesting, and exciting person to help me through this program. I am forever appreciative for having had the opportunity to work with you.

I would like to thank the thesis evaluators, Dominique Robert and Maritza Felices-Luna, as well as the chair of the defence, Line Beauchesne. I appreciate the time you invested in carefully reading and evaluating this thesis. Your questions were thought provoking and your suggestions contributed to great improvement of my thesis. Thank you for your time and energy.

I would also like to thank my friends Leah, Ana, Mabel, Michelle, and Steph. You have all given me support throughout this whole research process, even when you have absolutely no idea what I am talking about. You have been sources of great joy when I have been stressed or tired. I would not be the person I am today without you all.

Finally, I would like to thank my family. You have motivated me to work hard when the time calls for it, and to relax when it is needed. To my mother Jennifer, my father Jorge, my brother Cameron, and the rest of my family, of which there are too many to name, for pretending to know what I have been doing for the past two years. This project would not have been completed without your support.

# TABLE OF CONTENTS

# INTRODUCTION – ADOLESCENCE AND SOCIETY'S NEURO-TURN

There has been growing attention from the social sciences, and the general public, on emerging and ever-expanding neurological evidence for behavioural phenomena. Schneider and Woolgar (2015, pg.390) called this the "neuro-turn" in society. They claim that increased attention is being placed on how neuroscience can explain behavioural phenomena. Social scientific attention is turned towards neuroscience and the emerging techniques in the discipline. The attention of society generally is turned towards how neuroscience can define what humans are and why they behave the way they do. This neuro-turn has also infiltrated the legal realm, where the cultural authority of science allows certainty to be placed on scientific evidence that enters the courtroom (Aronson & Cole, 2009, pg.605). Law uses scientific, and specifically neuroscientific, evidence to add certainty to their decisions (Aronson & Cole, 2009, pg.606), but this relationship can work reciprocally as well. The use of scientific statements as fact in law is a way in which scientific propositions can gain facticity and build a longer network of connections. Law, as a cultural authority on truth, can add certainty to the statements concluded in scientific research.

This thesis, influenced by science and technology studies (STS), and more specifically Actor-Network Theory (ANT), focuses on how neuroscience contributes to our understanding of adolescence as well as the law's understanding of adolescence. I propose to use ANT to describe how adolescent behaviour is being 'neurologized' – explained in terms of neuroscience – within science and law. The focus of this study is 'facticity', that is, how assertions from neuroscience about adolescence become facts, and how the increased facticity of those assertions produces the

adolescent that is neurologized. I hope that this thesis will shine a spotlight on the social dimension of science and invite the reader to view science as a democratic endeavour, where facts about the world are not discovered, but are produced in laboratories.

Adolescence is an ambiguous period of development that has been defined differently across time and disciplines. A different definition or explanation of adolescence can be found within social, psychological, biological, neurological, and legal studies. Each field may focus on a different aspect of adolescent development and behaviour or have different methods to determine the start and end points of adolescence. Law has, over time, relied on different types of science to define adolescence and to determine the treatment of those adolescents. Currently, amidst the neuro-turn in society, the legal realm has rested quite a bit on neuroscience to help decide how to treat adolescents, specifically those involved with the criminal justice system. Therefore, I am interested in how the law can support and increase the certainty of claims made by neuroscience while also neurologizing the adolescent – defining the adolescent in terms of what neuroscience says about their behaviour.

This paper is limited to describing the neurologization of adolescence by the facticity gained by scientific propositions through three types of translations. It is not possible to investigate the entirety of the research available on the explanations of adolescent behaviour as there are a variety of characterizations, from a variety of fields of study. This thesis is a case study. The data is limited to a selected scientific article and documents from two United States Supreme Court cases. The scientific article is titled "Age Differences in Sensation Seeking and Impulsivity as Indexed by Behavior and Self-Report: Evidence for a Dual Systems Model" by Laurence Steinberg, Dustin Albert, Elizabeth Cauffman, Marie Banich, Sandra Graham, and Jennifer Woolard (2008). This article will be referred to as Steinberg and colleagues (2008). The

documents from the cases consist of oral arguments, *amicus briefs* submitted by the American Psychological Association (APA) and the American Medical Association (AMA), and court opinions for the *Graham v. Florida* (2009) and *Miller v. Alabama* (2012) cases. The data set may be limited, but the description provided will inform the reader on the social processes at work in science that produce facts and facticity surrounding adolescent behaviour. The results should be that the description resonates with a social understanding of science, not simply of the case being investigated, but of the process of scientific work in general.

In this sense, this thesis is focused on the neurologization of adolescence from a relational perspective, rather than a critical perspective. A critical perspective would aim to critique the science from the inside, to develop arguments against the methods used or the conclusions made. This kind of study of science would view the neurologization of adolescence as a turn to determinism, whereby everything is determined by biology or genetics. The argument here is that science is constructed through social and political motivations of the researchers. The institution of science is perceived as political and not objective, which lends to the conclusion that the science is not objective and the statements produced from science are simply constructed. I, however, take on a more relational approach to the neurologization of adolescence. The purpose is not to critique science from within, but to gain an understanding of the process through which it works. This is aimed at democratizing the practice of science. From Latour's perspective, the more constructed something is, the more real it becomes. This occurs through social, political, and scientific movements inside and outside the laboratory. I aim to show that science is political, but not in the negative sense that a critical perspective would. I want to understand how science produces statements that become engrained as facts in reality.

In order to achieve this goal, there are two important terms I would like to discuss. These are facticity and translation. First, facticity refers to how truthful a statement or entity is. That is, how is the statement perceived? One that has permeated science, law, religion, society, politics, and more, might have a lot of facticity. It has been taken to be true by many communities. Facticity can be gained through connections not only with the social world, but also the material world. The more connections a statement or entity has, the stronger its facticity, the more fact-like it is, the more real it is. A strong network of connections will increase facticity, while a weak one will decrease facticity. Second, translation is a way of describing scientific work or how researchers and scientists produce statements about the natural world (Callon, 2003, pg.58). It is a description of what takes place inside and outside the laboratory in order to produce statements that may become useful as a part of reality, statements that may gain facticity. Translation can be a movement as small as drawing a diagram in a paper based on results from a scientific instrument or as large as quoting a scientific article at an international conference. Each movement builds connections or severs ties, thus gaining facticity. These two terms will be discussed in further detail but provide some insight for now on the way in which science is studied in this thesis.

I study the facticity of the neuroscience of adolescence by using Actor-Network Theorist Michel Callon's "Science et société: les trois traductions" (2003) and "Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay" (1986). The former provides a way to understand different types of translations such as translating an entity from the outside world into the laboratory and translating elements within a laboratory. The latter provides an understanding of the detailed elements involved within a translation, which lends to the facticity of scientific propositions. I also use concepts from Bruno

Latour's "Science in Action" (1987). The work by Callon and Latour allows me to explore how the Steinberg and colleagues' (2008) text translated the adolescent from the outside world into the laboratory, how that adolescent was neurologized in the laboratory, and how that neurologized adolescent was then translated from the laboratory to the legal world, all while gaining facticity. I look both upstream and downstream of the article. Moving upstream allows me to study and understand the translation process that went into producing the neurologized adolescent and into producing a proposition about adolescence with strong facticity. Moving downstream allows me to study and understand the translation process by which the proposition gains more facticity and adolescent behaviour becomes more neurologized in the field of law. This provides a broad exploration of the facticity of neuroscientific facts about adolescence produced by Steinberg and colleagues (2008). I hope to highlight the process of scientific fact production in the field of neuroscience to provide a descriptive understanding of neurologizing the adolescent.

The goal of this project is to shed light on how scientific propositions gain facticity. I hope to answer two main questions: How does the scientific proposition put forth by Steinberg and colleagues (2008) secure, gain, and maintain facticity in the scientific and legal realm? How does this proposition gaining facticity influence the adolescent entity in becoming neurologized in the scientific and legal realm? These questions will be answered throughout this thesis, particularly in the upstream and downstream analysis of the paper. This will highlight the process of fact production inside scientific laboratories and fact solidification outside of scientific laboratories.

To support this exploration, I begin by providing an overview of the literature on adolescence. This is broken up into two parts. The first consists of the different fields in science

which attempt to define and explain adolescent behaviour, in order to demonstrate the vast array of explanations available to study. The second consists of the definition of adolescence according to law, including a description of the progression of juvenile justice in the United States. This provides an in-depth look at how adolescence has developed and evolved over time, leading to where it is currently headed today within law. The second chapter provides information on the theoretical background of this project and the research methods employed within ANT. This includes a brief overview of the evolution of science and technology studies (STS) in order to demonstrate where it started, the different strands of STS, and why I chose ANT. Following this, I discuss William James' Pragmatism to bring the reader into my perspective on truth and reality for this thesis. This leads directly into a discussion of ANT and the concepts within that are relevant to this thesis. A chapter is then dedicated to the analysis of the Steinberg and colleagues (2008) article. This consists of three parts, each reflecting one of Callon's three translations. The first describes Callon's second translation, the process of translation within the laboratory and how the neurologized adolescent was produced. The second part describes Callon's first translation and the decision of the researchers to define sensation seeking and impulsivity as two separate behavioural characteristics in order to translate the adolescent from the outside world into the laboratory. The third part then takes on Callon's third translation as I describe the process through which the text gains facticity and the adolescent is further neurologized in law. This is a translation from the laboratory to the outside world. Finally, the conclusion will arrange the three translations in a way that demonstrates a flow of facticity gained throughout the entire process, from the beginning decisions of the research through to its use in legal decisions. I conclude with the contributions this thesis makes to the conversation within ANT and facticity.

# CHAPTER 1: WHAT IS AN ADOLESCENT?

This chapter serves to describe the relevant literature that defines and studies adolescence. The two sections I present focus on how adolescence is defined, described, and explained in science and law. While there are other perspectives that may define adolescence differently, I focus on science and law as the most relevant perspectives for this project. This is because I am analyzing the neurologization of adolescence in science and law. They are the two most relevant perspectives for the particular case study to which this thesis is dedicated.

Within the section on scientific explanations, I provide a broad overview of the many factors that are used to describe and explain adolescent behaviour. In highlighting these many factors, it should become clear that there are many disciplines that study adolescence, but that I will be focusing on only a select couple of these as they relate to the case study of this thesis. The legal discussion touches on the way in which adolescence is defined and incorporated into law, specifically the criminal justice system. However, the focus is on how the incorporation of adolescence into the criminal justice system has evolved over centuries. This paints a picture of how law has gotten to where it is today regarding adolescence. These two sections provide a broad overview of the literature relevant to this thesis project.

## 1.1. Scientific Characterization of Adolescence

In establishing an understanding of adolescence for this project, a scientific characterization of adolescence must be developed. While there are many disciplines within science that explain adolescence uniquely, there is a consensus of how adolescence is defined and what characteristics make up the developmental period. That is, it is a period of development between childhood and adulthood (Ledford, 2018; Richter, 2006; Varlinskaya, Vetter-O'Hagen,

& Spear, 2013), where individuals go through many changes socially, biologically, neurologically, and psychologically (Blakemore, 2012; Van Duijvenvoorde, Achterberg, Braams, Peters, & Crone, 2016). Traditionally, adolescence is understood as a period of "storm and stress" (Guyer, Silk, & Nelson, 2016, pg.76; Van Duijvenvoorde et al., 2016, pg.136), or of "internal turmoil and external disorder" (Reuter, 1937, pg.414). It is a time of many changes in behaviour and roles for the individual. Adolescence is a transitional period of social development in which one is preparing for the independence and autonomy of adulthood (Anderson, 2016, pg.329). Erratic behaviour, social disorder, misconduct, reckless and risky behaviours, emotional instability, self-harm, interpersonal violence, getting into trouble with the law, and having difficulty with social roles and rules are generally understood as normal characteristics for this period of development (Adriani & Laviola, 2016; Anderson, 2016; Dahl, 2004; Reuter, 1937; Richter, 2006). Risky behaviours during adolescence are generally described as novelty or sensation-seeking behaviours such as alcohol or substance abuse, delinquent behaviour, and skipping classes (Varlinskaya et al., 2013). The description of behaviours throughout the transition from childhood to adulthood has reached a consensus in the scientific community, however the start and end points of adolescence are much less definitive.

Adolescence is generally understood, in the scientific community, to act as a continuum from childhood to adulthood. In other words, the transition from child to adult is not instantaneous. It takes time and small changes occur gradually, eventually transitioning the individual into adulthood. Behavioural, hormonal, and neuronal changes occur slowly throughout this period. However, defining exactly when adolescence begins and ends is a much more daunting task than simply describing the characteristics associated with this period in life. In the scientific community, the onset of adolescence has been much more easily defined than

the end of adolescence (Patton et al., 2018; Steinberg, 2016). The consensus here is that puberty defines the onset of adolescence (Adriani & Laviola, 2016; Blakemore, 2012; Ledford, 2018; Patton et al., 2018; Steinberg, 2016). Hormones released at the onset of puberty are said to inform maturation of neuronal connections in the brain (Adriani & Laviola, 2016), signalling the maturation of many bodily systems (Patton et al., 2018). On the other end, the transition into adulthood is much more difficult to define and involves more cultural variation (Blakemore, 2012). While some define the end of adolescence using brain developmental signals such as a drop in plasticity, or malleability, of development (Adriani & Laviola, 2016, pg.323), the majority use cultural and social roles to define the transition (Ledford, 2018; Patton et al., 2018; Steinberg, 2016). The end of adolescence from this perspective is defined as the time when individuals begin gaining full social responsibility and autonomy through events such as owning a home, getting married, becoming financially independent, or starting a family (Dahl, 2004, pg.9). So, the onset of puberty and the gain of social autonomy generally mark the span of adolescence within one's life.

These markers for onset and offset of adolescence are not age specific and therefore many studies measure adolescence across various age ranges. Age ranges that have been used are from 14 to 17 years of age (Modecki, 2008, pg.78), 12 to 17 years of age (Dornbusch, 1989, pg.252), 14 to 24 years of age (Ledford, 2018, pg.554), 10 to 22 years of age (Van Duijvenvoorde et al., 2016, pg.136), 10 to 24 years of age (Patton et al., 2018, pg.458), 10 to 19 years of age (Richter, 2006, pg.1902), and even one spanning to 30 years of age (Raznahan et al., 2011, pg.7174). It is very clear that even with a definitive starting point, the cut-off ages of adolescence range quite a bit. In addition to this range, over the past few years, there has been a decrease in the age at which puberty begins, meaning that the start of adolescence is also

beginning earlier in life (Ledford, 2018; Patton et al., 2018). At the same time, there has been an upward shift in age in terms of gaining social autonomy. Parenthood, marriage, and home ownership are occurring later in life, in part due to extended periods of education (Patton et al., 2018, pg.458). Not only do cultural definitions of adulthood vary, but in many cultures the markers of adulthood are being pushed into later life, therefore extending the end of adolescence and the transition into adulthood (Ledford, 2018). Thus, adolescence is a continuum that is extending slowly over time, making any scientific definition of adolescence vague and unclear.

Since the age range or span of adolescence is unclear, most scientific discussion of adolescence revolves around the characteristic behaviours present throughout the transition from childhood to adulthood. For my purposes, the relevant information on which to focus revolves around the scientific explanations for the behaviour that is characteristic of adolescence, such as risk taking and recklessness. Therefore, I focus on the description of adolescence and its associated behaviour rather than the specific ages that it encompasses. There are four main disciplines that advance different factors as explanations for why adolescence is comprised of these general characteristics. These four disciplines are discussed next as sociology, biology, neuroscience, and psychology. I begin with the social factors.

### 1.1.1. Parental Interaction, Peer Influence, and Social Contexts

Social factors play a large role in defining the end of adolescence, as discussed previously. Social factors such as home ownership, social independence from parents, and marriage can all help in defining the end of adolescence (Dahl, 2004, pg.14; Patton et al., 2018, pg.462). Adolescence involves the transition from the social roles of a child to that of an adult, as defined by the particular culture of a society (Dahl, 2004, pg.14), and therefore adolescence involves

much cultural variation (Ledford, 2018, pg.554). Sociological factors do not only play a role in defining the span of adolescence within an individual's life, but they are also involved in explaining the changes that occur throughout development.

There are three main sociological factors that are generally described to impact individuals throughout adolescence; these are parental interaction, peer influence, and social contexts (Casey & Jones, 2010). First, there is an increased drive for independence and autonomy from parents (Casey & Jones, 2010, pg.1189). Social institutions, notably families and parents, generally repress children from gaining full autonomy (Reuter, 1937, pg.421). In other words, parents tend to feel the need to protect children from the outside world in order to prolong their youth and innocence. Dornbusch (1989, pg.244) claims that as adolescents get older and strive for more independence, the parental domination of decision making is decreased and joint decision making between the adolescent and parent increases. By the end of adolescence, the decision making is made solely by the emerging adult. For this reason, there is some bickering and struggle between adolescents and their parents during this process which can sometimes be perceived as rebellion on the part of the adolescent. So, the changing interactions between parents and children throughout adolescence have important sociological influences on adolescent behaviour as the adolescent struggles for autonomy and independence.

Peer influence is also an important sociological component of adolescence. Casey and Jones (2010, pg.1192) suggest that peer groups can serve as a motivation for behaviours and can reduce control during adolescence. Additionally, Monahan, Steinberg, and Cauffman (2009) found that most risky behaviours, such as alcohol and substance abuse, take place within social situations, surrounded by peers. While much research focuses on the negative aspect of peer influence, Dornbusch (1989, pg.249) also highlights that peers can have a positive impact. Since

the adolescent is active in selecting their peers, there is a reciprocal relationship between the characteristics of the group and the characteristics that the adolescent embodies (Dornbusch, 1989, pg.249; Kiesner & Kerr, 2004, pg.494). Therefore, an adolescent who takes less risks is more likely to choose friends who also do not take many risks (Kiesner & Kerr, 2004, pg.494). So, peers can have a strong influence on adolescent behaviour, but this influence is not always negative and works in a reciprocal manner as well.

A final sociological factor that is considered, however much less frequently, is the social context of the parental influence or peer relationships. For instance, part of adolescence involves learning to navigate social situations which comprises gaining skills in regulating emotions and behaviour which align to the individual's long-term goals (Dahl, 2004, pg.18). During late adolescence there is much variability in educational and occupational goals which incorporate different social contexts (Ruschoff et al., 2015, pg.2). Ruschoff et al. (2015) discusses how these social contexts can have a large influence on an individual's behaviour. While norm-breaking or aggressive behaviour may allow one to gain popularity among peers in middle adolescence, this behaviour may be less valuable when entering late-adolescence and moving into more professional positions. When looking for employment, aggressive or risky behaviour is not as beneficial and therefore peers in this context may not influence one to partake in those types of activities. The social context can determine what type of behaviour is appropriate and may alter the impact of peers or parents on individual behaviour. Therefore, social context can provide a sociological explanation for the increase of risky behaviour throughout adolescence as well as its desistance in late adolescence and early adulthood.

### 1.1.2. Pubertal and Hormonal Changes

A second set of factors important in explaining adolescent behaviour stems from the discipline of biology. Within the biological perspective there is a focus on puberty and hormonal changes. The terms puberty and adolescence are sometimes used interchangeably, however, as Varlinskaya et al (2013, pg.343) notes, puberty is better understood as part of adolescence. They explain that typical changes during puberty involve increases in gonadal hormones, physical signs of sexual maturation, and behavioural alterations such as an increase in sexual desire. Adolescence is a broader period of development which encompasses puberty and ends later in life. From this biological perspective, adolescence is commonly referred to as beginning with puberty and ending with the transition into adulthood (Patton et al., 2018; Stevens, 2016). Puberty initiates growth and maturation of many different bodily systems such as the immune systems, the reproductive system, and the neurodevelopmental system (Patton et al., 2018, pg.458).

The neurodevelopmental system is one system that is actually very important for understanding the biological factors associated with adolescence. Gonadal hormones, at the onset of puberty, have strong influences on brain development (Anderson, 2016, pg.331). Currently, these research findings indicate that hormones released during puberty have a reciprocal relationship with brain development. Some neurobehavioural changes – behavioural changes resulting from neuron interactions in the brain – are the product of increases in hormones released during puberty, and some neuronal changes may actually trigger hormone release in puberty (Varlinskaya et al., 2013, pg.345). Research has also demonstrated a natural biological propensity for feelings of high intensity emerging at puberty and occurring throughout adolescence (Dahl, 2004, pg.7). Some increases in sensation-seeking behaviours, which are

typical of adolescents, have been suggested to be associated with pubertal changes (Varlinskaya et al., 2013, pg.345). Therefore, Varlinskaya and colleagues (2013) believe that puberty may be partially responsible for cognitive control, emotional regulation, and motivation. Puberty and its associated hormones are important factors in defining and explaining the onset of characteristics typically correlated with adolescence.

Biological factors are not only connected with neurological factors, but are also often associated with sociological factors, in order to build a more complete picture of adolescence. As puberty begins, physical changes occur including sexual maturation, and so the social experience of an adolescent begins to change (Casey & Jones, 2010; Dahl, 2004). As one looks more and more like an adult physically, the outside world begins to treat them more and more like one, socially (Dahl, 2004, pg.10). Thus, the biological understanding of adolescence is incomplete without considering how changes in physical appearance stemming from hormones impact the social experience of an adolescent. Pubertal changes can explain adolescent behaviour on their own or in conjunction with neurological and social factors, the former of which I review next.

### 1.1.3. Neuroscience and Brain Specification

The next range of factors and explanations of adolescence I will discuss are neurological. There is as much uncertainty in defining the age range of adolescence in the scientific discipline of neuroscience as there is in all the other fields discussed so far. When studying mice, or other rodents, defining adolescence is sometimes clearer, as Pautassi and colleagues (2008, pg.2016) define it as the period between postnatal day 28 and 42. Those who study humans are much broader when defining the age limits of this developmental period. Some will posit general age limits like van Duijvenvoorde and colleagues (2016, pg.135) who define it as being between the

ages of 10 and 22. The majority, however, will not provide exact age ranges for this developmental period (Adriani & Laviola, 2016; Blakemore, 2012; Casey & Jones, 2010; Guyer et al., 2016; Nelson et al., 2004), instead choosing to focus on the general period of life between childhood and adulthood. The focus of the research then is on the characteristic behaviour of adolescents, just as is done in the other disciplines like sociology and biology.

Within the field of neuroscience, there is work being done on animal models, such as mice and monkeys (Casey & Jones, 2010; Wolf & Koenigs, 2015), as well as with functional magnetic resonance imaging (fMRI) (Stevens, 2016; Van Duijvenvoorde et al., 2016; Wolf & Koenigs, 2015). Animal models have aided in understanding the behavioural and neuronal components of development throughout puberty and adolescence (Dahl, 2004, pg.2). Animal models most commonly make use of rodents and monkeys like in the case of research conducted by Casey and Jones (2010) and Wolf and Koenigs (2015). One example of animal models being used to study adolescence are experiments on the effects of ethanol on adolescents versus adults (Pautassi, Myers, Spear, Molina, & Spear, 2008; Spear & Varlinskaya, 2005). The research produced from these studies has demonstrated that adolescent rats are less sensitive to the 'hangover effects' of alcohol, such as sedation, acute withdrawal, and motor function. These studies focused specifically on substance use, however, it is believed to be applicable to understanding general risk-taking behaviours of adolescence as well. This kind of research explains behaviours characteristic of adolescence through brain function in animals that are scientifically determined to be comparable to humans.

In addition to animal models, fMRI studies have also contributed to characterizing and explaining adolescence. Magnetic resonance imaging (MRI) machines make use of magnetic energy to measure both brain structure and brain function, but fMRIs focus on function by

analyzing brain activity (Wolf & Koenigs, 2015, pgs.2-3). fMRI is a powerful and widely used tool within the study of adolescence because it can process information from the main structures of the brain associated with emotional responses and behavioural integration (Guyer et al., 2016, pg.75). Stevens (2016) discusses the differentiation between resting state and task-based connections within the brain, in studies using MRI technology, to expand the understanding of brain organization from puberty to adulthood. Task-based connections are those that are active during the performance of specific tasks while resting state connections are those that are active in an absence of any performance of tasks. These studies have shown that the overall structure and organization of the brain is established at birth, while developmental changes occurring later on involve efficiency and specialization of neuronal connections. Different brain regions mature throughout adolescence and create reciprocal connections in order to become more coordinated with each other (Adriani & Laviola, 2016, pg.323). fMRI studies also allow scientists to study social cognition, emotion, and cognitive control while performing tasks (Blakemore, 2012, pg.112). This can help uncover events occurring in the brain when adolescents are making decisions and provides explanations for why individuals partake in more risky activities in early to middle adolescence (Guyer et al., 2016), rather than in childhood or adulthood.

Within the discipline of neuroscience, it is recognized that adolescence is associated with slow improvement over cognitive control – such as improving inhibition – while at the same time having heightened sensitivity to sensation, social stimuli, and affective stimuli – such as reward sensitivity and responsivity to peer influences (Van Duijvenvoorde et al., 2016, pg.136). This depiction of adolescence is further agreed upon within the general scientific community as well (Blakemore, 2012; Guyer et al., 2016; Van Duijvenvoorde et al., 2016). The adolescent is one that is impulsive or lacks self-control and enjoys engaging in risky activities. This consensus

of characteristic adolescent behaviour, within the scientific community, is explained in neuroscience by focusing on connections within the brain. Adolescence is thus described as a period of development in which new links in the brain are established, allowing for more connections between affective processes, such as reward sensitivity, and cognitive processes, such as impulse control (Dahl, 2004, pg.21; Steinberg, 2010). While the impact of socio-cultural and biological factors on social behaviour are large, both of these are believed to influence the brain which then responds to produce certain behaviours (Nelson et al., 2004, pg.163). Therefore, animal studies and fMRI research provide useful information for characterizing adolescent behaviour as a result of responses in the brain to social and biological stimuli.

### 1.1.4. Developing Personality

The final scientific discipline that has contributed to an understanding and explanation of adolescent behaviour is psychology. Developmental psychology has supplied a lot of knowledge on cognitive and emotional development in adolescence through behavioural studies. Research in this area has gained momentum in the last 50 years as psychologists use behavioural and clinical research to define adolescence as a unique period of development (Dahl, 2004, pg.9). Dahl (2004) explains that using a similar time frame for adolescence as biological studies, psychologists have studied emotional, cognitive, and social maturation throughout adolescence. In addition, there has been clinical research with considerable focus on the development of emotional, behavioural, and substance abuse issues throughout adolescence. This research has added important knowledge to the scientific definition of adolescence. While the focus here, and the focus of most research on adolescence, has been negative aspects of behaviour and development, it is important to note that there are positive aspects to increased risk taking and sensation seeking personality characteristics as well. This is known as the positive psychology

movement where the behaviours expressed in adolescence are studied in a different, more positive light, to understand the benefits of the changes that occur (Rich, 2003). While this perspective of adolescent behaviour is not the focus of this project, it is important to note that there is a small, growing amount of research being done on the benefits of risk taking during the developmental period of adolescence.

Psychological factors are most concerned with an individual's emotional and personality development. This provides an explanation for why adolescents are so strongly impacted by peers and other sociological factors in their decision making. Some research has indicated that adolescents are strongly influenced by emotional experiences, peer norms, and peer pressure because they lack a maturity of judgement (Modecki, 2008). This means that there is a strong influence of psychosocial factors on the cognitive decision-making process in adolescence, unlike in adulthood when this influence is weakened. This is not the only difference in emotions and personality between adults and adolescents. Both adolescents' and adults' personalities follow what Soto and Tackett (2015) call the cumulative continuity principle, wherein personality becomes increasingly stable over time. However, only adult personalities adhere to the maturity principle which states that people become "more agreeable, conscientious, and emotionally stable with age" (pg.359-360). Youth and adolescents have personalities that, instead, adhere to the disruption hypothesis. This means that the social, biological, and psychological transition from childhood to adolescence is correlated with a transitory decline in some maturity aspects of their personality. In other words, rather than a linear increase in maturity from childhood to adulthood, there is a decrease in certain maturity characteristics in adolescence before they increase into adulthood. This is consistent with the view that adolescent behaviour consists of recklessness and increased delinquency.

Some studies have demonstrated a similar finding that sensation seeking behaviour is distinct from impulsivity, and both sensation seeking behaviour and impulsivity have very different patterns of development (Casey & Jones, 2010). This helps to explain why adolescents can appear more impulsive than children. The understanding is that sensation seeking and sensitivity to rewards develops very quickly during adolescence, therefore making them less risk averse and more impulsive. Additionally, cognitive, social, and developmental psychology studies have found that cognitive control is not fully developed in adolescence (Casey & Jones, 2010, pg.1191). Cognitive control involves resistance to temptations or being able to delay immediate gratification. During adolescence, one may appear to be very impulsive because their sensitivity to rewards is heightened, while their self-control has not fully developed. It has been posited that the higher vulnerability of adolescents to taking risks is due to a combination of heightened inclinations to seek excitement and rewards, and relatively little capacity for cognitive control (Casey & Jones, 2010). Therefore, adolescence, not childhood, is the period of development consisting of the most risk taking. This research, in general, develops a picture of adolescence as a time of risk-taking and behavioural development.

The scientific consensus on adolescence is that it is a transitional period from childhood to adulthood (Ledford, 2018; Richter, 2006; Varlinskaya et al., 2013). The specific time period of adolescence is difficult to define (Modecki, 2008; Raznahan, 2011; Richter, 2006). However, there are clearly many factors and scientific disciplines that can be used to explain adolescent behaviour. Adolescence is accompanied by biological and psychological changes which influence neuronal development (Blakemore, 2012; Van Duijvenvoorde et al., 2016), and these all make the adolescent more susceptible to social and environmental influences (Nelson et al., 2004). Behaviour becomes more erratic, impulsive, and risky throughout this developmental

stage of adolescence (Adriani & Laviola, 2016; Anderson, 2016; Reuter, 1937; Richter, 2006). All of these factors provide important insight into the scientific understanding of adolescence today. There are a variety of perspectives that can be used to explain adolescent behaviour. For the purposes of this thesis project, I focus on neuroscience and psychology as the scientific disciplines and explanatory factors of adolescent behaviour. A final important perspective on adolescence that I discuss next is the legal perspective. This characterization of adolescence is important for this thesis project and diverts from the scientific explanations already described.

## 1.2. Legal Characterization of Adolescence

The scientific concept of adolescence as a transitional period of development between childhood and adulthood does not appear to be compatible with how law functions. Rather, the law characterizes two important phases in development: childhood and adulthood, leaving no transition room between the two (Scott, 2000). Instead of a continuum from child to adolescent to adult, there is a distinct separation of child and adult, and a bright line separating the two. According to law, a person is either a child or an adult and there is no developmental period between these two phases in life. There is some recognition that adolescence is distinct from childhood and adulthood within law (Scott, Grisso, Levick, & Steinberg, 2015), however involving this continuum of maturation would add complexity with little payoff, confuse the system, and impede smooth processes (Scott, 2000, pg.577). Thus, while there is a recognition of adolescence, the bright line separating child from adult is maintained. The age at which adulthood is considered to have begun, however, is an issue that the law shares with science.

As with scientific characterization, there is no clear age at which adolescence begins or ends. Scott (2000) discusses the age of majority as the age at which *presumptive* adult legal

status is attained. In the United States, this age is 18. However, depending on which law or policy is being studied, this age may be lower or higher. For instance, a person can begin learning to drive at 16, vote at 18, and drink legally at 21. Thus, law has decided, mostly based on society's understanding of childhood, that certain roles, responsibilities, and privileges should be granted to a person at different times in their life, rather than attaining all of them at once. This is based on a social understanding of the age at which an individual is responsible enough to handle those certain powers, privileges, and responsibilities. Altering the age of majority for particular issues demonstrates that law does attempt to involve a more current understanding of individual and behavioural development. It takes into account the existence of adolescence as a developmental period in that it decides individuals are not fully matured but can handle certain responsibilities. Felsman (1996) provides a coherent example of this bending of the line in their description of Human Immunodeficiency Virus (HIV) testing in the United States. States that require parental consent are premised on the assumptions that parents are more mature and have the experience necessary to handle health care decisions, and that parents choose to act in their child's best interest. However, in areas such as Sexually Transmitted Infection (STI) testing, the law sometimes recognizes that adolescents are able to make responsible decisions and that the benefits of allowing independent access to testing outweighs the costs of eliminating parental consent. In issues where adolescents may avoid treatment because their parents are required to know, the law makes exceptions to the child/adult dichotomy in order to protect the health of the adolescent (Felsman, 1996, pg.348-349; Scott, 2000, pg.571). Therefore, in legal proceedings regarding health concerns, adolescence can be, in part, taken into consideration.

This period of adolescence is also partially incorporated into criminal law. A binary definition in criminal law, and more specifically in sentencing within criminal courts, forces a

person convicted to either be sentenced as if they have complete culpability or very little culpability (Scott, 2000, pg.553). The issue with this binary definition of development arises when a young person commits a particularly heinous crime, such as assault or homicide. In these instances, criminal law allows for a youth to be tried in adult court and to be subject to more harsh, adult sentences (OJJDP, 2012). Therefore, criminal law recognizes that youths begin to mature throughout adolescence and are more culpable than children. However, criminal law does not incorporate knowledge on how long adolescence can persist. As discussed in terms of scientific consensus, the time frame of adolescence is unclear and many study adolescence as a period ending in the mid to late twenties (Ledford, 2018; Patton et al., 2018; Raznahan et al., 2011; Van Duijvenvoorde et al., 2016). The knowledge that adolescence can last past 18 years of age is not acknowledged in law. While an individual under 18 years of age can be tried in adult court for what are considered atrocious crimes, an individual over 18 years of age is never tried in youth court for lesser crimes or due to the mitigating circumstance of developmental capacity. Therefore, this knowledge on adolescence only works and is only incorporated into criminal law in one direction: towards an earlier onset of adulthood. This is a general description of adolescence as recognized in criminal law. However, in order to get a fuller picture of adolescence in law, we must first go backwards in time. I will now present a description of law's understanding of adolescence and the progression of juvenile justice over time since the 17$^{th}$ century. This includes a discussion on the incorporation of science in legal decisions surrounding the treatment of adolescents in the criminal justice system.

### 1.2.1. The Progression of Juvenile Justice in the United States

In science, there is a general consensus of what characterizes adolescence with many methods or factors used to explain the behaviour. In law, there has been an evolving

understanding of what characterizes adolescence, based on ever-evolving explanations. Over centuries, in the United States, juvenile justice has progressed in somewhat of a cyclical fashion[1] where treatment of youth is considered harsh, becomes more lenient, then returns to being harsh again (Shoemaker & Wolfe, 2016). The periods of lenient sentencing are focused on treatment and rehabilitation of juvenile offenders, while the periods that are more harsh are focused on punishment and retribution (Scott, 2000, pg.578; Shoemaker & Wolfe, 2016, pg.17). Bernard and Kurlychek (2010, pg.3) have termed this progression the "cycle of juvenile justice".

The cycle, according to Bernard and Kurlychek (2010), begins with juvenile crime being thought to be unusually high. The punishments available are very harsh, and middle ground treatment is not available. The options for punishing juvenile offenders are perceived to be too harsh or too lenient, meaning that there is a "forced choice" (pg.4) between severe punishment or no punishment at all. The high juvenile crime rate is blamed on the "forced choice" because the two options of punishing harshly and doing absolutely nothing are believed to increase crime. A major reform is then brought in to introduce more lenient treatment of juvenile offenders, creating a middle ground option. After some time, juvenile crime is believed to be unusually high again, this time being blamed on the lenient treatment of the youth. There is an increase in harsh punishments and a decrease in lenient ones, bringing the cycle back to the beginning. This cycle can be observed over time in the United States, from the 17$^{th}$ century through to present day America. This progression in the United States appears to also involve a cycle of evolving explanations, where decisions are made about juvenile justice based on social, then scientific, and then again a social consensus of juvenile delinquency. As the progression of juvenile justice

[1] Though I focus on the United States, the same pattern has been observed in Canada as well.

is presented, this pattern of the incorporation of scientific evidence, and then its fading from use, should become clear.

### *1600s and 1700s – Children as Probable Losses*

Bernard and Kurlychek (2010) define two ideas of childhood that emerged when people began separating children from adults. In the 1600s, children were defined more by the fact that they were probable losses – expected to die young – than the fact that they were human beings. Prior to the 17th century, children could be a source of joy for families, however there was no expectation of a long life. This was the first idea of childhood. The second idea of childhood emerged in the 1600s, where there was a slight decline in infant mortality and children were beginning to be seen as a potential adults. This conception of children emerged from Puritan beliefs (Mays & Winfree, 2006, pg.40). Children were considered to be born in original sin, and therefore it was up to the parents to subordinate their children and to teach them Christian beliefs (Mays & Winfree, 2006, pg.39). Bernard and Kurlychek (2010, pg.42) emphasize that children were believed to be inherently inclined toward evil, but could still be saved if influenced appropriately from the moment of their birth. At this time there was no idea of youth requiring special treatment, therefore juvenile offenders were treated as if they were adults (Shoemaker & Wolfe, 2016, pg.17). Thus, the 17th century represents the beginning of the cycle, where young offenders are treated the same as adults. In other words, they were punished with harsh sentences.

At the beginning of the 18th century childhood was becoming more important than ever before (Mays & Winfree, 2006, pg.40). Arthur (2017) describes this as the time in the age of enlightenment where childhood was beginning to be perceived as a distinct period of development from adulthood. Children were understood to be innocent and have cognitive

differences from adults. These ideas about childhood resulted in developing notions of parental responsibility, as well as the idea that the well-being of children should be of general interest to general society and the government. While ideas around childhood were changing, youths were still treated as adults when it came to crime and they were expected to learn their role in society simply by being individuals who took part in society (Mays & Winfree, 2006, pg.36). Juvenile justice was slowly starting to turn towards different treatment of youth, however the harsh punishments remained the same.

### *1800s – Children as a Product of their Environment*

The progressive era, or the child-saving movement, came in the 1800s as a reaction to social problems occurring in crowded, urban cities (Mays & Winfree, 2006, pg.44). This movement originated with the child savers, individuals who saw pauperism and crime in the city and wanted to protect children from following down that path (Bernard & Kurlychek, 2010, pg.54; Shoemaker & Wolfe, 2016, pg.19). The goal of the child savers was to create social and legal systems that would reform juvenile offenders, preventing future pauperism and crime (Shoemaker & Wolfe, 2016, pg.28). There were three main causes of pauperism and crime in which the child savers believed. These were weak parents who were not raising their children properly, temptations of the street in urban cities, and children having a weak moral nature (Bernard & Kurlychek, 2010, pg.54). These problems were to be solved by creating a separate system for juvenile offenders and treating them differently than adults (Scott, 2000, pg.580).

In order to create this separate system for juvenile offenders, the behaviour being targeted first needed to be defined. The term juvenile delinquency, according to Bernard and Kurlychek (2010), first appeared in 1819 as a concept related to children. It consisted of the second idea of childhood – children as potential adults – extended into the teenage years, which eventually

came to be known as adolescence. The term juvenile delinquency was applied, for the most part, to low- or working-class youth in urban cities, and was used to describe behaviours related to stealing property. Then, once juvenile delinquency was defined, child savers could build a system that would be meant to apprehend these youth and mold them into properly functioning individuals (Bernard & Kurlychek, 2010, pg.45; Ellison, 1987, pg.9). The juvenile justice cycle was progressing towards what was considered more lenient treatment for young offenders as they were now being seen and treated as different from adults.

The first step towards fixing the social problems of society was creating Houses of Refuge, the first of which was established in 1825 (Bernard & Kurlychek, 2010, pg.33; Shoemaker & Wolfe, 2016, pg.19). Houses of Refuge were meant to be the middle ground between punishing youth as adults and choosing to do nothing about their behaviour at all (Bernard & Kurlychek, 2010, pg.63). They acted as substitute parents for the children who were deemed to need extra help (Shoemaker & Wolfe, 2016, pg.20). The houses functioned by removing these 'juvenile delinquents' from their home and their parents, placing them in a different location, and providing them with a disciplined program in order to address their weak moral natures (Bernard & Kurlychek, 2010, pg.54). Houses of Refuge were popular for a long time as they addressed all three perceived causes of pauperism and crime: the family, the street, and the weak moral nature of juveniles.

After some time, placing out worked in conjunction with Houses of Refuge, or sometimes replaced them altogether as the popular method for dealing with youth considered to be a problem (Shoemaker & Wolfe, 2016, pg.26). This method, described by Shoemaker and Wolfe (2016), consisted of temporarily placing the youth in a local home or institution. The

youth could spend up to a year in a House of Refuge, then be sent out for contracted service. The placements were meant to be temporary, however they could last until the age of 21.

A second system for managing these youth, first established in 1846, was the creation of training schools, also known as reformatories. Shoemaker and Wolfe (2016, pg.26-28) also provide a clear description of this juvenile justice reform. Reformatories were small cottages within a compound that, again, were meant to act as a replacement for the natural family of the youth that was perceived to be deficient. Again, as with placing out, youth were given indeterminate sentences. The difference with reformatories, however, was that youth were trained for an occupation so that they could eventually become productive members of society. The main goal of all these juvenile justice reforms was to treat and rehabilitate the youth, rather than simply punish them, as they would do with adult offenders.

In the middle to late 1800s, science and scientific theories began to be introduced as a way to justify the juvenile justice decisions being made. In 1859, Charles Darwin's theory of evolution was released, and from this, social Darwinism emerged. Bernard and Kurlechek (2010, pg.72-73) explain that within social Darwinism, individuals believed that humans evolved from lesser species, and therefore some individual human beings were superior to others. Cesare Lombroso, inspired by the theory of evolution, produced his theory of atavistic criminals. Lombroso saw criminals as evolutionary throwbacks to earlier evolutionary states that were less civilized and more inclined towards violence. This scientific evidence reinforced the notion of low- and working-class children, and their parents, as evolutionary throwbacks with weak moral natures, in need of reformation. Science was now being used to reinforce the beliefs of the child savers, and the use of those theories in legal decision making reinforced those scientific theories as reliable and accurate.

The term adolescence then emerged around 1870, along with the medical model of behaviour. There were major shifts in the definitions of childhood and adulthood, including the shift towards defining adolescence as a period of development between childhood and adulthood, as discussed by Mays and Winfree (2006, pg.42). Youth in the low and working classes were losing independence because they were the last individuals hired, but the first individuals to be fired. So, these youth were staying at home longer and extending the period in life known as childhood. This emergence of adolescence came with scientific theories about behaviour. G Stanley Hall proposed that adolescents lived in a primitive psychological state, somewhere between being savage and civil. He described it as a period of development characterized by willful behaviour and moral indifference. Also, at this time, psychoanalytic theory became popular for explaining how personality develops in stages and how experiences at each stage could alter development (Shoemaker & Wolfe, 2016, pg.38). The popularity of these then fell in the 1900s as new ideas about adolescence and juvenile delinquency were emerging. However, for that time, these scientific theories played a large role in the definition of adolescence, the treatment of juvenile delinquency, and the sentences for young offenders.

With all of this emerging information on adolescents and juvenile delinquency, it was decided that a separate justice system needed to be created to effectively manage and treat the target population (Arthur, 2017; Mays & Winfree, 2006; Scott, 2000). Separating youth from adults would ensure that the young people could not be corrupted by the adults in adult prisons (Arthur, 2017, pg.14). The idea was to have a separate system that would be non-punitive, non-stigmatizing, and involve therapeutic courts (Arthur, 2017, pg.15; Mays & Winfree, 2006, pg.134). To achieve this, the court hearings would be confidential, non-adversarial, and informal so as to accommodate the needs of the youth (Mays & Winfree, 2006, pg.134). The focus at this

time was still on the rehabilitation and treatment of youth, rather than punishment, and treating juveniles separately from adults. This separate juvenile justice system required an age range over which it would have jurisdiction. While each state varied, in general, the minimum age of jurisdiction of the juvenile justice system would be seven, and the maximum age would be 16 or 17 (Mays & Winfree, 2006, pg.135; OJJDP, 2012). The maximum age today ranges as high as 18 while some states today have no minimum age (OJJDP, 2012). The mission of this system was to provide an appropriate punishment as a response to delinquent activity, and also to provide a welfare response for the youth guided by the notion of *parens patriae* (Mays & Winfree, 2006, pg.133), which means the state takes a parental role in child welfare. In this sense, the separate court and justice system would protect young offenders from the stigma and brutality of the adult criminal justice system. The first United States juvenile court was established in 1899 (Bernard & Kurlychek, 2010, pg.33; Scott, 2000, pg.578; Shoemaker & Wolfe, 2016, pg.33), thus officially treating youths as separate from adults.

### *1900s – Children as Dangerous Criminals*

The cycle of juvenile justice turning back towards harsh punishment is highlighted by Bernard and Kurlychek (2010, pg.183-184). In the 1900s came the belief that youth were being treated too leniently. The 1960s and 1970s saw some Supreme Court decisions that suggested treating juvenile delinquents as fundamentally similar to adult criminals while also producing a juvenile justice system that was fundamentally different from the adult system. The decision was between treating youth as malleable and different from adults, or hardened criminals who were just like adults. In 1974, the Juvenile Justice and Delinquency Prevention Act was established (Shoemaker & Wolfe, 2016, pg.42). It required states to either eliminate or revise their status offense laws and to provide community based programs as an alternative to correctional

institutions. This resulted in net-widening. Previously, youth who were in conflict with the law were either tried and sentenced to an institution or let go, but now there was a middle ground option again. More youth were being tried and sentenced, thus increasing the number of youth caught in the system, resulting in higher reports of crime rates.

This net-widening implying unusually high crime meant that tough policies were again believed to be required to reduce the problem. This was the 'get tough' movement which transformed the idea of juvenile delinquents from being understood as different than adults to simply being described as little criminals with equal culpability to adults (Bernard & Kurlychek, 2010, pg.184). The legislation and juvenile justice policy being produced reflected this idea, with a focus no longer on the rehabilitation of young offenders, but rather on the protection of victims and society (Giardino, 1996, pg.233). One major piece of punitive legislation was introducing waivers and transfers to the adult court system (Baird & Samuels, 1996, pg.191; Giardino, 1996, pg.233). This began in the late 1980s and involved the decision to try a juvenile offender as an adult in the adult court system in order to have more harsh, punitive sentencing options (Shoemaker & Wolfe, 2016, pg.77). Shoemaker and Wolfe (2016) discuss many different ways a youth can be transferred into adult court. Some of the options include being transferred based on the severity of the crime committed, the discretion of the prosecutor, and the discretion of the juvenile court judge. This meant that more youth were being given harsher sentences because they were being tried as an adult. In addition, the concept of "once an adult, always an adult" meant that subsequent offenses would be tried in adult court automatically (Mays & Winfree, 2006, pg.138). The late 1900s saw a rise in severe punishments for youth, with the use of transfers peaking in 1994 (Shoemaker & Wolfe, 2016, pg.44). However, since then the use has decreased, and more middle ground punishments have been introduced once again.

### *2000s and Today – Have your Cake and Eat it Too*

The juvenile justice system in the United States today has moved to a twofold approach, characterized by Shoemaker and Wolfe (2016, pg.45). One side of this approach sees less serious offenders being given treatment and rehabilitative programming aimed at diverting offenders away from the criminal justice system. The other side sees serious offenders being transferred to the adult court system. These two systems work simultaneously, so the harsh punishments of the 1900s are beginning to be replaced with the option for middle ground sentences once again.

At this time, there is also a re-emergence of scientific evidence and theories being used as justification for legal decisions, especially at the level of the Supreme Court. The United States Supreme Court case *Roper v. Simmons* (2005) was one of the first in the field of youth criminal justice to reintroduce the idea of juveniles as cognitively and developmentally different from adults, and to use psychological and neurological evidence to support their decision (Shoemaker & Wolfe, 2016, pg.158). The decision from the court opinions, written by Wagner (2005, pg.569), was based on new evidence from the biological and psychological sciences that claimed that children had an underdeveloped sense of reasoning and were capable of committing serious crimes without understanding them. The court decided to eliminate the death penalty as a sentencing option for youth based on the scientific evidence confirming that even a youth who commits the most serious crime cannot fully understand the consequences and is not fully culpable. In the late 1900s there was a turn to harsh punishments to the point where the United States again hit the 'forced choice' in the cycle of juvenile justice. The 21$^{st}$ century, now, represents a shift back to more middle ground punishments and sentencing, while also securing another increase in scientific evidence as justification for the decisions. Evolving information

and knowledge from the scientific disciplines of psychology and neuroscience are once again playing a role in juvenile justice progression in the United States.

The juvenile justice cycle is ever continuing and producing new understandings and definitions of adolescence. At one point in time there were only children and adults, adolescence did not exist. Later, new ideas of childhood emerged, and adolescence became a new concept to define the period of development between childhood and adulthood. Then, adolescence came to mean someone who is in need of reformation and rehabilitation because of their poor upbringing. The 1900s introduced the concept of adolescence as a dangerous period in life, where individual juveniles posed a risk to society and needed to be controlled. Today, law defines adolescence as a time of neurological development. This communication between the law and the sciences is further developed in my analysis. Before I can delve into the analysis however, I need to provide a description of the theoretical background of this thesis. This will better prepare the reader to understand the analysis in chapter three and the theoretical decisions I will make.

# CHAPTER 2: UTILIZING THEORY – HOW TO STUDY THE NEUROLOGIZED ADOLESCENT

The previous chapter discussed the scientific and legal knowledge surrounding the adolescent – how it is defined, what behaviour characterizes it, how adolescent behaviour is explained, and how it is managed within the criminal justice system. All of this was to develop an understanding around how adolescence has been defined in the past and how adolescence is defined in the present. I presented a broad range of the literature in these two areas in order to set the stage for the analysis of this thesis. However, before I am able to analyse how the neuroscientific explanation for adolescent becomes a fact, how it gains facticity, and how this produces a neurologized adolescent, I must present the theoretical background on which this thesis relies. I hope to demonstrate that the neurologized adolescent is an entity produced through a network of connections in both neuroscience and law. For this, I describe how science produces facts and how those facts are solidified in the world outside of the science laboratory, particularly in law.

The first section of this chapter is focused on the different sociologies of science that could be used to study the neurologization of adolescence. Within this, I discuss first two sociologies that represent dominant views of science taking on a correspondence model. These are Merton's science as a social system and Kuhn's history of science. This then allows me to describe a constructivist sociology, sociology of scientific knowledge. This will build an understanding of the many streams of sociologies of science available to use in this thesis. I, however, fall within a relational view of science. Therefore, following this section, I discuss William James' American Pragmatism to bring forth the relational view of science that I take in this thesis. This will provide details of the ontological position of this thesis and what it means

for something to be true. I have chosen to use ANT as a guide for my description of the network produced and solidified around neurologizing the adolescent entity. Therefore, it is important that I provide an overview of ANT, followed by a discussion of the difference between science as correspondence and science as translation. This will highlight how I will be studying science, as translation.

Once the theoretical background of this thesis has been presented, I provide an overview of how I will be studying science as a process of translations. This includes a description of Callon's three types of translations and his four moments of translation. Other relevant concepts within ANT will be highlighted and I will depict the way in which these will be used in the analysis. Finally, I cannot move to the analysis without first recognizing a couple of criticisms of ANT. These will be discussed briefly. I will also explain why ANT remains the right choice of theoretical background for this thesis project despite these criticisms. All of this will build up the knowledge required to then move to chapter three, where I will provide an analysis of facticity and the neurologization of adolescence in science and law.

## 1.3. Sociologies of Science and Facticity

The first piece of theoretical background to discuss is 'facticity' and how different perspectives on scientific research can impact the sociological research project. This will serve to focus my project on the neurologization of adolescence from a relational, rather than a normative or correspondence, perspective. This section characterizes distinct sociologies of science and how the different sociologies define and study 'facticity' within scientific discourse. The term facticity refers to how scientific propositions come to be perceived as factual. That is, a statement's facticity is determined by how much it is entrenched in reality and by the strength of

the network of connections surrounding it. This will be an analysis of the different ways a researcher can study the formulation of 'truths' or 'facts'. I have chosen to use Actor-Network Theory (ANT), however there are a range of sociologies of science and I must therefore expand on how each can be used to study science, and more specifically, fact production. I will not directly discuss ANT as that will be discussed shortly after, however I will discuss the concept of symmetry and its connection to epistemologically separating constructivist sociologies of science and relational sociologies of science such as ANT.

This section will highlight how the different views of science and scientific research are debated, from correspondence to constructivism, leading into a discussion of the relational perspective of science. I begin with a discussion on Robert K. Merton's science as a social system. I then provide an overview of Thomas Kuhn's history of science. These each take on a correspondence perspective of science. This is followed by a review of the sociology of scientific knowledge (SSK) which takes on a more constructivist perspective of science. This review includes a description of the strong programme, symmetry, and double symmetry. This should set us up for a discussion of the relational perspective on truth in which this thesis works.

### 1.3.1. Science as a Social System

The first sociology of science I want to discuss is Robert K. Merton's science as a social system or phenomenon. Merton's early work honed in on the institutionalization of modern science in the West, while his later work focused on describing the structure and functioning of modern science as a social phenomenon (Restivo, 1995, pg.96). This discussion will focus on the latter, the Mertonian paradigm that took form in the late 1960s and early 1970s Merton's focus

was on science as an autonomous social system making it independent of social influences (Restivo, 1995, pg.96). Therefore, Merton adopted a normative perspective of scientific research.

The main goal within this particular sociology of science is to study the social behaviour of scientists, not to study the science itself (Martin, Nightingale, & Yegros-Yegros 2011; Rohracher, 2015). Merton insisted that norms play an important role in defining what behaviour is permissible and that reward systems institutionalize the production of knowledge (Callon, 1995, pg.36). Norms act, not as constraints on conduct, but as justifications for the behaviour of scientists (Edge, 1995, pg.10). Therefore, the motivations behind the action of scientists are not their own, as there is a pattern of institutional control over a large range of motives that characterize the behaviour of scientists (Cronin, 2004; Fuller, 2006, pg.77). This normative structure includes four main norms. These are organized skepticism, disinterested objectivity, universalism, and communism or communal ownership of ideas (Cronin, 2004; Fischer, 2007; Fuller, 2006; Small, 2004).

The first norm, organized skepticism, as describe by Macfarlene and Cheng (2008, pg.69), involves remaining skeptical about the results of research until all facts have been established. This means remaining cautious in making conclusions and is meant to drive scientists to challenge conventional wisdom. Small (2004) defines disinterested objectivity, the second norm, as paying attention to who and what is being cited or referenced in a scientific paper. This means paying attention to whether the researcher is citing themselves or others, and why they are citing those particular people. This reflects the degree to which the interests of the scientist doing the citing is linked to the interests of the scientist being cited. Therefore, scientists should have no financial or emotional attachments to their work and citations should be based on the scientific work being referenced, not the author (Macfarlene & Cheng, 2008, pg.69). The

third norm, universalism, highlights that all claims to truth should be evaluated by the same impersonal criteria, not on the scientist's personal characteristics, such as race (Macfarlene & Cheng, 2008, pg.69). Additionally, these same authors discuss that a scientist's career should only be held back by incompetence and not by any personal characteristics. Since science is seen as an objective, impersonal task, the concept of universalism is vital to scientific discovery. It allows the production of universal and objective knowledge. Finally, Small (2004, pg.73) discusses communal ownership as emphasizing science as a collaborative effort. This means that scientific knowledge should be viewed as having common ownership and that withholding information and keeping secrets only slows down the rate of discovery. Thus, these four aspects of the normative structure of science outline the basic justifications for why a scientist chooses to study a particular issue and how they choose to conduct their research.

Based on these four aspects of the normative structure of science, Robert Merton posited that the social structure of science is stable, that deviance is unconventional, and that science cannot be easily moved once it has been institutionalized (Restivo, 1995, pg.98). Therefore, just like any other institution, any developments within science would need to be supported by the group norms (Restivo, 1995, pg.97). This view demonstrates how Merton's science as a social system studies scientific advancement from a correspondence perspective, as it develops an understanding of science as a stable institution and scientists as rational beings. Scientific work is studied as objective discoveries about the natural world separate from the social world. Facts are discovered in science by following the institutional norms. This sociology studies scientific work from the same perspective that scientists use in studying 'nature'.

Science as a social phenomenon takes for granted the positivist view of science (Edge, 1995, pg.7). Here, science is perceived to be a rational activity. Scientists pursue their research to

logical conclusions, resulting in either the acceptance or rejection of their theories and hypotheses (Fuller, 2006, pg.15). They follow the norms of universalism, disinterested objectivity, communism, and organized skepticism to separate themselves from the scientific work and to be objective about their findings (Cronin, 2004; Macfarlene & Cheng, 2008; Small, 2004). Scientists are held accountable only for the intended consequences of their research, unlike other professionals who are held responsible for the intended and unintended consequences or meanings of their knowledge (Fuller, 2006, pg.15). In this perspective, scientists are objective researchers who hold no responsibility over the unintended consequences of their work as long as they follow the four norms of the institution and are not influenced by outside social factors. They are only influenced by the objective science and the results they find. Thus, the reality of the natural world is discovered by the scientists doing research and what is of interest to the sociology of science researcher is not the science itself but the social behaviour of scientists, the social norms of the institution, and the continual push for discoveries.

### 1.3.2. History of Science

The second sociology of science that fits within a correspondence view of science that I want to discuss is the history of science. The history of science was developed by Thomas Kuhn in his book "The Structure of Scientific Revolutions" (Edge, 1995; Fischer, 2007; Fuller, 2006; Rohracher, 2015). Kuhn focused on the natural sciences, specifically physics (Fischer, 2007, pg.552), to argue against the cumulative and linear growth of scientific knowledge that Robert Merton posited (Rohracher, 2015, pg.201). Instead, Kuhn believed that development in the sciences was characterized by shifts in scientific paradigms, shared within a scientific community and not able to be judged by the same standards as another scientific community (Fischer, 2007, pg.553; Rohracher, 2015, pg.201). Thus, Thomas Kuhn's history of science was

focused on understanding the process through which scientific knowledge progresses (Callon, 1995, pg.29). Within this sociology of science, it is not the behaviour of the scientists that is of interest, but rather the way in which scientific knowledge comes into and out of focus, is taken as fact or proved to be fiction.

Kuhn described the scientific progress of discoveries through scientific paradigms. He developed the term 'paradigm', but the exact meaning that Kuhn attributed to paradigms has been debated a lot. Therefore, I present here one interpretation of what was meant by scientific progress through paradigm changes in order to demonstrate the general idea of how one might study scientific progress from this perspective. This definition of paradigms is presented by Advocate (1998) who says that paradigms constitute the fundamental concepts and basic experimental practices of a particular scientific discipline. The scientific community will go through periods of time where normal research takes place and research findings are consistent with previous knowledge from previous research. Then, during extraordinary times, new research findings become inconsistent with previous research. The work then becomes about disproving these new findings, fitting it in with previous work, or disproving the previous research. Throughout these periods, it may be decided that the old paradigm is no longer consistent with new research findings and a new paradigm is required. Controversy in the scientific community is high during these periods. Thus, the scientific paradigm survives until anomalies accumulate and the paradigm falls to new information, knowledge, and discoveries. At this point, the paradigm shifts to encompass new or altered concepts and experimental practices so that the research results fit within the paradigm being used once again. Here, the paradigm is only considered to be factual if discoveries about the natural world from the scientific laboratory can be explained appropriately through it. To reiterate, this is one of many

interpretations of Kuhn's 'paradigms' and is used as a demonstration of the type of research done within the sociology of science known as the history of science. It is a focus on the progression of scientific work within the scientific community and the way in which this progression occurs.

The history of science, therefore, takes on a correspondence perspective of scientific research and fact production, just as Merton's science as a social system. It also takes on a positivist view of science just like science as a social system. The behaviour of scientists is what is being studied as the science itself is objective and factual. The history of science adopts the perspective that there is a nature to be studied, and the work of studying that nature involves the scientific community. Both Merton and Kuhn's sociologies of science have a cultural view of science. The scientific community conducts research to determine information about the natural world and the research conducted, decisions made, and findings published are based on the cultural norms of the institution, according to Merton, or the progression of research according to discussions within the community, as with Kuhn's work. These sociologies of science work from the perspective of facts that scientists take on, where they are researching nature, but focus on studying the cultural and social actions occurring within scientific institutions, rather than studying the science itself.

### 1.3.3. Sociology of Scientific Knowledge (SSK)

One practice that diverged from the correspondence perspective of Merton and Kuhn is the sociology of scientific knowledge (SSK). This sociology of science takes on a more constructivist standpoint on scientific research. The main object of study within SSK is the natural science itself. This focus allows the researcher to demonstrate that even the most empirical, scientific work has cultural and social influences (Rohracher, 2015, pg.202). The aim

of SSK is very humanistic. It intends to understand the social nature of scientific knowledge. In this way, SSK brought more attention to understanding the role of public spheres, society, and political engagement in technoscientific disciplines (Fischer, 2007, pg.564). Thus, the focus was no longer on the paradigms within science disciplines or the social system of science, but on the science being conducted itself.

SSK makes an important distinction between the product of science and the process of science. Older sociologies of science, like that of Robert Merton and Thomas Kuhn, observed the processes within scientific disciplines but believed that they would all end in the same place or with the same product (Martin et al., 2011, pg.13). They took a correspondence perspective on scientific knowledge claims, where the facts produced within scientific communities are real and truly representative of the natural world, separate from the social world. This reality is separate from human beings. Within SSK, the process is part of determining the end point or the product (Martin et al., 2011, pg.12-13). This perspective adopted by SSK contains a more constructivist stance on scientific truth claims, where the end product is determined by the science that takes place and by the acceptance or rejection of claims to truth. This means that reality is constructed by the processes that take place in a scientific community. From this point of view, all knowledge that emerges from the scientific laboratory was constructed through social processes and therefore facticity is based on how well the scientific propositions are fabricated. A second emphasis of SSK is the recognition that the rules can be applied to work within the practice of SSK itself (Martin et al., 2011, pg.12). Therefore, one could study researchers within the field of SSK and research produced from the field of SSK in the same way that SSK researchers study scientific practice.

### *The Strong Programme and Symmetry*

Within SSK, David Bloor and colleagues developed the strong programme. According to Martin and colleagues (2011), this scientific perspective within SSK originated in the Edinburgh school. It systematically criticized traditional sociologies of science, like that of Merton, through historical studies which revealed the social nature of science. This practice focuses on knowledge as a form of life. It involves a much stronger focus on understanding how claims to truth in the field of science emerge, and are accepted or rejected (Rohracher, 2015, pg.202). Rather than studying the science itself, the focus is aimed at the social interactions that occur within the scientific community in the construction of truths (Rohracher, 2015, pg.202). Micro level analysis is performed to demonstrate the social and cognitive interests, as well as activities of the key social actors involved in scientific practices (Martin et al., 2011, pg.13). They employ very thick descriptions of the daily activities and debates involved in establishing scientific facts (Martin et al., 2011, pg.13). For this purpose, researchers within the strong program often analyze historical case studies to understand how decisions within the scientific community and decisions about scientific claims are impacted by interests in the wider society (Rohracher, 2015, pg.202). The focus is on the social and political aspects of society that influence scientific practice and construction of facts.

David Bloor, as a strong contributor within this field, characterized much of the philosophy within SSK and the strong programme. A very important aspect developed within SSK is that of symmetry (Martin et al., 2011, pg.12). He stressed an impartial attitude towards success and failure within science (Latour, 1992, pg.7; Martin et al., 2011, pg.), meaning that both successful and unsuccessful knowledge claims within scientific practices should be empirically analyzed in the same way. Successful science is research that has garnered social

support and is believed to be factual. In other words, it was constructed well. Unsuccessful knowledge claims are those that have not garnered social or political support of their facticity. Using the principle of symmetry, less importance is placed on distinguishing between science and pseudoscience, and more emphasis is placed on studying the construction of facts and how statements come to be considered facts, or studying 'facticity'.

### *Symmetry versus Double Symmetry*

Bloor and colleagues developed a sociology of science that lies within constructivism, whereas Bruno Latour, Michel Callon, and others turned away from constructivism. One important distinction between the two groups is that of symmetry versus double symmetry. SSK researchers, including Bloor, are intent on remaining impartial towards successes and failures within science, however human beings continue to be considered separate from the 'natural' world (Martin et al., 2011, pg.13). The social and political life within science influences which constructed statements gain facticity. From Latour's perspective however, the social and political are intertwined with the scientific work (Fuller, 2006, pg.63). Therefore, the more a statement is constructed, the stronger its network of connections, and the more real it is. From this perspective, reality is produced through social, political, and scientific work. It is neither a correspondence nor constructivist perspective on scientific research, but rather a relational one.

Latour and colleagues distinguish a second dimension of symmetry, where human beings are completely intertwined with the natural world (Fuller, 2006; Rohracher, 2015). According to this symmetry, society and nature need to be treated the same way (Latour, 1992, pg.8). They believe that it is not possible to maintain the distinction between humans and non-humans (François, 2011, pg.165; Graham, 2009, pg.383). There is a connection between objects that are produced in science and the social world (Knorr-Cetina, 1995, pg.145). Nature and culture are

not separate and thus human and non-human actors should be treated with the same agency (Martin et al., 2011; Rohracher, 2015). According to François (2011), while humans intervene in non-human life, the reverse is also true; non-humans interact with and influence human life. Human beings and the natural world are no longer perceived to be completely separate, but instead are intertwined and interact with each other. Thus, Latour and colleagues work under the principle of double symmetry, where successes and failures are examined in the same way, and humans and non-humans are treated the same. In this way, ANT moved away from the correspondence and constructivism perspectives of scientific work, and towards a more relational perspective, known as American pragmatism. In the next section, I take time to develop an understanding of this relational perspective so as to be clear about the viewpoint this thesis project takes on scientific work, truth production, and facticity.

## 1.4. William James' American Pragmatism

Before describing ANT, I want to provide an overview of the ontological position I take in this thesis. This situates me in a relational perspective of the neurologization of adolescence. Here, I describe American Pragmatism as posited by William James (James, 1988) in order to contribute to the understanding of the relational view of science and reality that is implemented in this thesis. This form of Pragmatism is said to provide a middle ground between realism and constructivism (Viney, 2001, pg.211). That is, American Pragmatism views science not as objective fact discovery or as social and political actions constructing statements, but as a combination of these two where the social, political, scientific, and more are all interconnected. Within this view, human experience is constructed (Viney, 2001, pg.219). This means that a person's thoughts and ideas are dependent upon their previous experience, and their experience is dependent upon what they noticed or paid attention to in the past (Skowroński, 2011, pg.339).

Experience is defined not only as information from the senses, but also awareness of recollective, deliberative, affective, and relational components of an event (Viney, 2001, pg.220). James emphasizes the constructed nature of ideas and truths, while also maintaining that some ideas and truths work practically better than others (James, 1911, pg.76; 1988, pg.97). So, while there is a constructed nature, James highlights that within pragmatism there is a reality that contains truths. Those ideas and pieces of information that work practically in reality are facts. Therefore, all concepts, ideas, and truths are constructed or produced, but they function in reality. Concepts become defined by their functionality in experiences (Kuklick, 1988). This relational perspective of reality will be further developed through a discussion of James' ideas on pluralism, radical empiricism, and truth and facticity.

### 1.4.1. Pluralism and Individualism

Skowroński (2011) says that pluralism can be understood as a range of acceptable ways in which reality can be composed and interpreted, and there are many meanings or values that can be taken from experiencing reality. They explain that an individual, when observing something for research, will necessarily select certain items to which they pay attention, and others to reject or ignore that are not perceived as relevant to the project, or which does not harmonize with other items being observed. Therefore, the knowledge stemming from the observation is due to elimination of certain items and retention of others. In experiencing reality, using particular attention and interest, the focus is narrowed (James, 1911, pg.61; Viney, 2001, pg.219). This process of narrowing restricts what is noticed and appreciated from the world, and this process is known as 'habits of attention' (Skowroński, 2011, pg.339). Habits of attention are those things that an individual pays attention to and what they notice throughout their experiences.

Skowroński (2011, pg.339) provides an explanation of habits of attention that I summarize here. Habits of attention are impacted by social, political, and physical contexts of past experiences. For instance, four tourists visiting a destination will have different memories and experiences of it, even though they all visited the same place. One may have picturesque impressions, the second may pay attention to the details of daily life, the third will only remember public places, and the last may not take note of anything other than street names. Each individual will select and eliminate certain objects, spaces, people, and more in order to suit their particular interests. This process shapes their experience, which then shapes subsequent habits of attention. The individual's education, values, norms, and ideas will inform how they perceive certain situations and experiences. Habits of attention tell us that a person's empirical thoughts are dependent on what they have experienced, their educational training, and more. One thing may appear in front of someone many times, but this does not mean that it will necessarily be noticed the same way each time or that it will be noticed at all. On the other hand, something may appear in front of someone once and be remembered for a long time. Therefore, through the concept of pluralism, individual experience plays a large role in determining what information is used or disregarded in experiences. This can be translated into research where habits of attention may impact what information researchers determine to be relevant, what they notice, and what information they decide to eliminate. The way the information is processed would be based on past experiences, education, research, and more.

William James emphasizes the individual role in shaping history and shaping the direction in which things are moving (Viney, 2001, pg.222). He believed that historical change came about through individuals as well as forces of culture and environment (James, 1988, pg.31; Viney, 2001, pg.222). He proposed an individualism that is conditioned by the

environment where nothing that is real can escape from its environment. The environment determines the conditions of change by selecting, preserving, modifying, and destroying, but it is also altered by human interaction (Viney, 2001, pg.214).

This pluralism can be applied to the study of science as well. James believed that humans are moved by desires, or by interests (Boisvert, 2012, pg.112). Therefore, scientists choose what to study based on their interests. They decide what is important to study and eliminate everything else. Then, once in the laboratory, they pay attention to the instruments they choose and ignore the others. They notice the results they believe to be important and throw away the others. They read the work of their colleagues that they believe to be valid and refute the rest. In the same way, the instruments used only measure certain information while disregarding the rest. Therefore, pluralism, as well as individualism, is present in scientific inquiry and discourse. The decisions made by the scientist are based on previous experience and habits of attention. This is not to say that scientists and researchers are purposely ignoring certain research or information. Their experiences have shaped their habits of attention and this results in certain information being taken notice of more readily than other information. The idea is that a different researcher may notice different information or the same information. A different tool may result in different findings or the same findings. The exact results of a research project are the result of the many conditions of the research, habits of attention of the researcher being just one. The concept of pluralism within James' pragmatism is directly applicable to the sociological study of science.

### 1.4.2. Radical Empiricism

Radical empiricism can be used in conjunction with American pragmatism and is another concept that is relevant to this thesis. The general idea stemming from radical empiricism is that

every piece of knowledge or of an experience is held together with every other piece of that knowledge or experience through connections or relations, and those connections are also part of the experience or knowledge (James, 1911, pg.xii). James uses the term empiricism to talk about hypotheses which are liable to being modified through future experiences, and therefore, continuing experiences are the best testing ground for truth claims made about reality (James, n.d., pg.22; Viney, 2001, pg.220). In other words, James believed that the things about which we have the strongest assurances are always subject to change through individuals, elements, concepts, tools, and more in future experiences. The term radical is used to denote the idea that only things which are definable through experience are things that can be debated to be true, and anything that is experienced cannot be excluded from debates on what is true (James, n.d., pg.22; Viney, 2001, pg.220). A question arises then, about how something can be true and yet also be subject to change.

According to James' radical empiricism, things are connected with each other in many ways, but nothing can be connected to everything. There are connections that are constantly being dropped and added, there are connections that are dormant, and there are some connections which are found to be indirect, or needing an intermediary link (Viney, 2001, pg.221). While a connection between two experienced things may be severed, those experiences are still maintained through other connections (James, n.d., pg.20). These connections and disconnections are realized through the particular questions asked about reality (Throntveit, 2011, pg.277). Therefore, every decision that goes in to determining a research question will necessarily impact the truths 'discovered' in the laboratory. In this view, reality is being gradually constructed and is always in the making (Viney, 2001, pg.221). Truth, in other words, is a process (James, 1988, pg.98). The interpretation of the world, the reality that is known, is

rarely definite, final, static, or objective (James, 1988, pg.98; Skowroński, 2011, pg.338). Truth and reality are constantly in the making through new experiences that make new connections and sever old ones. New knowledge, concepts, tools, and more are constantly required to be incorporated into new experiences. This description of reality then, requires that there be a definition of what is considered truth, or what contains facticity. In other words, we want to know how to determine the difference between ideas about the world that are correct and those that are not.

### 1.4.3. Facticity According to American Pragmatism

James concluded that truth is made, just as things like strength and wealth are made (James, 1988, pg.92). This is why he describes the world as unfinished (Throntveit, 2012, pg.255), and not static, definitive, or final (Skowroński, 2011, pg.338). Reality and truth are constantly in the making. The reality that is accessible to humans through experience is continually changing through new experiences and habits of attention. Within American pragmatism, William James argues that there is truth and that truth has a history (Viney, 2001, pg.216). This theory of truth is a genetic one, where the processive, contextual, and continually expanding nature of human experience is emphasized (Viney, 2001, pg.215). The truths accepted by humans have a fragile nature as they experience connections, but also disconnections (Viney, 2001, pg.215). Therefore, reality is fragile and ever changing. It is fragile and ever changing because of connections and manipulations occurring through experiences.

From this perspective, truth is constantly being made and changing. But how do we decide that something is true or has facticity? James (1911, pg. v; 1988, pg.91) argues that any concept or idea that agrees with reality is true, while those that disagree with reality are not. True ideas are those that guide us satisfactorily through the environment in which we live (Kuklick,

1988, pg. xiv). This means that to be true, a statement or idea must agree, it must work either practically or theoretically in reality (James, 1911, pg.218). If the idea or concept works or functions in the world then it is true. Therefore, true things are those that resist. They resist charges of falsity. They maintain the connections and relations necessary to satisfy the needs in the world and those necessary to agree with reality. This perspective can be applied to studying science. Science is one of the most fascinating realms to study from this perspective due to science's authority over reality.

The term 'pragmatism' comes from a Greek root, which when translated refers to things being accomplished or done (Viney, 2001, pg.216). Truths are meant to lead to a course of action, to something productive or with consequences (Throntveit, 2012, pg.259; Viney, 2001, pg.216). However, Viney (2001, pg.216) explains that there are also truths which do not have direct utility and are considered to be extra truths. These remain isolated until a time comes when they can form connections which make them useful in the world. So, a belief that one has can be true, but pragmatically and practically useless for the time being. On the other hand, a belief held at one time may be practically useful but determined later to be cognitively false. For instance, Viney (2001, pg.217) provides the example of how navigating using Ptolemaic cosmology – the model of the universe with Earth at the centre – was successfully used in the past but determined to be an inaccurate and untrue representation of the world. For James, a fact is known through experience, it is a feature of experience that holds its connections and relations for a period of time (Viney, 2001, pg.217). Ptolemaic cosmology was true because it worked practically during that time. However, as more ideas were developed through experiences, the idea of the Earth at the centre of the universe no longer agreed with reality. The connections and relations it had with other pieces of knowledge and experience no longer held together and it was no longer true.

Therefore, truth is a process of agreement (James, 1911, pg.v; 1988, pg.91). It is constantly being made and changing. It is fragile. True ideas agree with reality and false ideas disagree.

This concept of truth and reality can be applied to the study of science as well. Scientists perform experiments in their laboratories where they discover truths about the world. These experiments and research projects are experiences through which facts come to be known. These scientific discoveries must make connections with other discoveries or knowledge in order to be stable for a period of time and to be considered a truth. This is why I take William James' relational view of the neurologization of adolescence. I regard the scientific research in this thesis as relational. The more strong connections it can make, the more true it is, and the more facticity it gains. American pragmatism, as proposed by William James, will inform the methodological decisions made and the justifications of these decisions for the current project studying the production of the neurologized adolescent as a fact and the further solidification of this neurologized adolescent entity as fact in law.

## 1.5. Actor-Network Theory

ANT is not only a theory, but a set of tools, to help describe network connections between human and non-human actors. In order to understand ANT, two terms need to be described, namely actor and network. Due to the double symmetry principle in ANT, an actor can be both human and non-human entities. Latour (1996, pg.7) defines it as an actant, "…something that acts or to which activity is granted by others". This implies that humans have no special motivation, just like the non-human actors in the network. The second term, network, speaks specifically of the connections between actors. Latour (1996, pg.4) says that there is nothing but networks. Some may be longer or more interconnected than others, with different allies or actors involved, but everything works in networks of these connections no matter how

small. Therefore, an actor-network is a system of connections between non-human and human actants.

Sociology of science studies can be conducted from a constructivist perspective such as SSK, or from a relational perspective like ANT. This relational perspective makes use of something known as material semiotics. Therefore, in order to discuss ANT, an understanding of material semiotics is required. Semiotics highlights that the significance of a term is dependent on the strength of its relations, specifically between the term and its neighbours (Law, 2002, pg.91). In other words, facts are dependent on holding together a strong network of relations, or a strong actor-network. In ANT, the focus is on material semiotics, which means that there is a focus on the networks of relations around the materials involved in the network. In this material semiotics and relational view, realities are done, they are practised into being in networks of relations (Law & Singleton, 2014, pg.388). According to Law (2002, pg.91), this perspective views facts, and reality, as an effect of forming stable networks of relations with actors, such as people, institutions, objects, and more. The focus of study is on exploring the relations that hold objects, organizations, subjects, and facts stable. ANT, developed by Bruno Latour, Michel Callon, and others, attempts mainly to understand science innovation and technological changes (Law & Singleton, 2014, pg.380). ANT suggests that facts remain a reality only while its network of relations between it and any neighbouring facts, objects, people, and more, remain steady (Law, 2002, pg.93). ANT understands scientific practices as both semiotic and material, and views these practices as performing politics (Law & Singleton, 2014, pg.380). ANT is discussed less as a theory and more as a toolkit for understanding these networks of relations (Law, 2009, pg.141-142). This is because it is heavily descriptive. It details how relations assemble, do not assemble, or break apart. Therefore, the focus is on understanding and

describing how statements in science are produced, stabilized, gain facticity, and then become engrained in reality.

ANT studies how science produces facts, but what exactly is a fact? What is meant by facticity in this perspective? Latour (1994, pg.26-31) provides an explanation of how facticity is developed in scientific research through what he terms the five horizons of scientific research. He discusses how five horizons of research contribute to building longer and stronger actor-networks. The first horizon consists of the mobilization of the world, where the focus is on the scientific laboratory. Instruments, tools, and more are mobilized in order to conduct research. The second is empowerment of the research where scientists create colleagues in the scientific community who will either be convinced of the research or will dispute the research. These colleagues determine the scientists' right to assert based on the research. The third horizon is that of alliances, where the scientists form alliances with people who could be interested in the realization of the project. The fourth horizon, staging, involves public relations where the scientific work is put towards resolving delicate problems. The final horizon is links and connections. This contains scientific ideas, concepts, activity, and more. The ideas are stronger when they are connected with a large number of horizons. Being able to hold together actors from across the four other horizons builds a long and strong actor-network. Facticity, however, is never done. It is a constant process of building stronger and longer connections. Some connections may be lost or severed while others are gained. For this reason, we cannot say that something has gained facticity[2]. The actor-network is simply growing. This is a different

[2] Since we cannot say that facticity is gained, I will instead use the term solidity to note the growing and strengthening of an actor-network. As more connections are made, the actor-network gains solidity, but the facticity is never achieved.

perspective of fact production or 'discovery' than is often thought of in a normative, or correspondence model of science, discussed next.

## 1.6. Two Models of Science: Correspondence versus Translation

Within a normative view of scientific research, society is divided into two distinct parts, a political and a scientific world. François (2011) describes this perspective with a scenario presented by Bruno Latour. The scenario unfolds as follows: Plato described a society where individuals who were part of the social and political life were prisoners in a cave and the only ones who could tell them the truth about reality were a select few individuals who left the cave to study nature. These few were the philosophers, now more commonly known as scientists, who could study nature because of their education. In this view, scientific work is separate from the rest of the world, and scientists are seen specifically as separated from nature (Callon, 1995, pg.37). Scientists remove themselves from social life in order to get access to the truth about reality, of which there is only one (François, 2011, pg.163). From this normative perspective, science is a process of discovery, of remaining objective, separating the specific issue from the world and studying it in a laboratory. Scientists have knowledge, tools, practical rules, and education which allow them to study nature as it is (Callon, 1995, pg.41; François, 2011, pg.164). Scientists have knowledge which allows them to conduct experiments, interpret data, and make statements about that data.

As François (2011, pg.167) notes, a normative perspective on science views scientific discourse as legitimate on its own and in need of no further justification. There is only one thing to represent, that is the one reality that exists, the nature out there separate from human beings, and there is only one way to represent that reality. The one way to represent reality is the method

that leads to the largest amount of objectivity possible, therefore the way to study reality is through scientific discourse. Science is given authority over speaking about nature and is perceived to have direct and privileged access to the truth. The core idea within this modern perspective of science is that it is science as correspondence, meaning that science is objective and scientists study a reality that is separate from social beings. Scientists study nature separate from human interaction, and the results represent the one true reality. In this sense, scientists are like prophets who bring truth to people who cannot see it for themselves. Callon (1995, pg.39) terms this science as a sociocultural practice. Scientific knowledge is a response to and interest in predicting or controlling reality. Scientists want to understand nature to predict, prevent, or intervene in particular issues. The goal of this science as correspondence is to be objective, separate nature from social beings, and learn about the truth of reality. Therefore, a normative, correspondence perspective talks about facticity as referring to scientific knowledge coming from what is considered to be the most objective work.

Latour suggests, from a relational perspective, however, that science is a process of translation. A scientist, alone in a laboratory, sharing information with only themselves, goes nowhere and produces nothing. Without colleagues, the scientist's findings are not circulated. Without social and political connections, the research does not have as much traction. This view of science focuses on the process of translation: the work being done in science laboratories to produce facts. In other words, translation is each movement made throughout the scientific process that produces a statement about reality. The focus is on the process of how nature is translated from the world to scientific laboratories, and then to journal articles and books (Latour, 1999), and then how the knowledge from that research is translated back to the outside world (Callon, 2003, pg.59). Callon (1995, pg.46) describes this translation process as there

being constant interaction between inscriptions, – tables of data, reports, articles, graphs, and notebooks – scientific instruments, and technical skills which leads to the development of statements. These statements are produced from a series of displacements, where data goes into a scientific instrument, the instrument creates an output, the output is translated into numbers or graphs, and then is translated into a sentence from the scientist after interpreting the information. Each displacement is a movement of the object of study. Inscriptions, scientific instruments, and human beings are joined together and interact together to form statements. Within this model of science, nature and society, or human beings, are not so separate. Translation does not view science as objectively studying a reality or nature that exists outside of human interaction, rather, science inherently involves social and political interaction of human and non-human actors. These interactions and connections do not mean that the scientific statements produced are not true or that they are weak. On the contrary, the more interactions and connections, the longer and stronger the actor-network. Latour says that the more the statement is constructed, the more it is real.

This model of science is termed extended translation, which refers to any action or operation that links scientific instruments, statements of fact, and human beings (Callon, 1995, pg.45). Extended translation, according to Callon (1995), begins with the assumption that the primary objective of scientific inquiry is to produce statements. These statements are produced from a translation chain, a series of displacements which allow for the statement to be made. Within this model of science, the distinction between nature and society is believed to be outdated (François, 2011, pg.165). Unlike the previous model, extended translation does not view science as objectively studying a reality or nature that exists outside of human interaction. Instead, objectivity is impossible, and humans interact with nature to produce reality (François,

2011, pg.167). The products of science are not seen as given entities that were discovered by science, but rather as entities produced in the laboratory (Knorr-Cetina, 1995, pg.143). Therefore, scientific work takes part in producing reality, rather than studying it. Just as with Latour's five horizons of scientific research, facticity is never done, and as with James' American Pragmatism, truth is a process. Scientific research is a process of interactions and connections between actors, building a long and strong actor-network. Those with the longest and strongest connections hold true. They work practically because they have such connections. As a researcher studying science within ANT, I also recognize that I become an actor in the network as well. I form connections to the other human and non-human actors in the network. As I open up the scientific work to be able to see the process of fact production, I am performing the network. Now that I have laid some groundwork for the theoretical background of this project, I describe how I study the translation process in the analysis.

## 1.7. Studying Translation

This thesis is focused on studying fact production in science laboratories. In order to accomplish this, I investigate the translations that occur throughout and after the scientific process to produce facts and solidify their facticity. I studied the following empirical materials: a scientific article from Steinberg and Colleagues titled "Age Differences in Sensation Seeking and Impulsivity as Indexed by Behavior and Self-Report: Evidence for a Dual Systems Model", the oral arguments from the *Graham v. Florida* and *Miller v. Alabama* Supreme Court cases, the court opinions released from those cases, and the amicus briefs submitted by the AMA and APA for each of those cases. I use mostly concepts from the work of Michel Callon to aid in organizing and describing this process in the analysis. I also borrow some terms from the work of Bruno Latour. In this section, I describe the concepts from ANT that are crucial for this thesis.

This first involves establishing Callon's three types of translations. These three translations are described throughout the analysis as I explore the translations moved through by the scientific research I study. I then discuss Callon's moments of translation to develop an understanding of the movements that can be involved in each translation. I follow this with a review of some terms and concepts developed by Latour that make up part of my toolkit for analysing and describing the translation process. These terms are inscription *devices, stacking, modalities*, and *black boxing*. Finally, I provide an explanation as to how these ANT concepts and terms are applied to the case study of the scientific research neurologizing the adolescent entity.

### 1.7.1. Callon's Three Translations

There are three types of translations put forth by Michel Callon in his 2003 article titled "Science et Société: Les Trois Traductions". Callon describes three different types of translation that generally occur throughout the process of scientific research. The first type is the movement of translating the world as a macrocosm, into the microcosm of the science laboratory. So, when studying something in the laboratory, the researchers must choose which entities, or actors from the outside world to translate into the laboratory. This means translating the complex, uncontrollable world to a controlled environment that can be manipulated. This process allows the scientist to study nature in a controlled experiment or setting. Studying this first type of translation involves studying the decisions made before the research began. How did the researchers choose to define actors within the network? How were all of the elements in the research brought in from the outside world?

The second type of translation is the action of translating the events in the laboratory, the results from the inscription devices, and nature itself into scientific writing and journals. The

process allows the nature being studied to be transported to paper where diagrams, statements, and more depict the facts that were 'discovered'. Studying this second type of translation involves studying all of the decisions made in the laboratory. This can include studying the instruments of measurement, the evidence presented, the way the authors cite previous research, the way the conclusions of the research are presented in the final, published paper, and more. Here, we ask how the actors within the research hold together in a strong or weak network.

The third and final type of translation is about returning to the outside world. This is a translation of the nature studied, back to the large, complex world from which it originally came. This is the diffusion of information that was gained in the laboratory, by the scientist, to the public. When the information is passed to the public, it becomes knowledge about reality that people other than scientists now know as reality or truth. Studying this type of translation is about focusing on how the research is disseminated to the world outside the laboratory after the research is complete and the conclusions are drawn. How is it received in the public? In law? In politics? The focus is on whether or not the research is translated beyond the science laboratory and accepted as fact in the world outside the laboratory. Each of these three types of translations will be discussed in the context of this project, but first, I provide an overview of Callon's moments of translation.

### 1.7.2. Callon's Moments of Translation

Michel Callon described four moments of translation: problematization, interessement, enrollment, and mobilisation of allies in his 1986 article titled "Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay". Each of these moments can be observed throughout the three types of translations, and they all cooperate with

each other to maintain a network of connections[3]. These moments occur throughout the translation process and can overlap. During the translation, whether it is the first, second or third type, the identity of actors in the network, their interactions, and their movements are negotiated. However, at any time, the network can be contested, and this is known as dissidence. Here, I provide a description of each of these moments of translation, as well as what constitutes an act of dissidence.

The first moment of translation is *problematization*. *Problematization* consists of describing the network of connections and alliances between actors or entities. In this moment, the identity of the actor is defined and what the actor wants from the network is identified. The *problematization* describes the process of movements that allows alliances and connections between actors in the network to be forged. This moment brings in actors from the social and natural world. They are all actors within the network, they all have identities within the network that must be defined, and they all, in a sense, want something. What is important in this moment of translation is that the identities of the actors and the links between them are established.

The second moment of translation, *interessement*, consists of the actions which impose and stabilize the identity of actors within the network. In this moment, one entity involved in the network, such as researchers performing an investigation, have defined actors in the network through their problematization. This entity, the researchers, perform an action, or actions, in order to stabilize the definition of the actors within the network. There are a range of devices that could be used to perform the action and to achieve the goal of *interessement*. In order to achieve

[3] These moments are comparable to Latour's five horizons of scientific research (1994), discussed previously. I chose to focus on Callon's moments, however overlap exists between the concepts and they could be used in conjunction with each other.

this goal, the actions taken may have to include severing the actor's connections to other identities or roles outside of the network. The moment of *interessement* attempts to stabilize the identities of actors, in part, by interrupting competing associations that exist outside of this particular network. So, actions are taken, using the necessary device, to sever the actor's ties to other roles, and to stabilize its identity within the network. All of this is aimed at constructing a system of alliances to solidify the facticity of the network, and to ensure a long and strong actor-network.

The third moment of translation is *enrollment*. This moment involves negotiations, tests, and tricks. These occur alongside the actions of *interessement* in order to ensure that the stabilization of the actor's identity succeeds. These multiple and ongoing negotiations and tests help to determine and test the identity of the actors. This resolves the definition and distribution of the roles of the actors within the network. For the identity of an actor within a network to be stabilized, it must succeed in the tests and negotiations.

The final moment of translation is *mobilisation of allies*. This concerns who the spokespeople are and on behalf of whom these spokespeople are communicating. When all of the actors are stabilized in the network, researchers may publish a paper or speak at conferences. The published document, or the researchers, become the spokespeople for innumerable actors. All of the actors have been mobilized in the work of the researchers. If the mobilisation is successful, then "…a constraining network of relationships has been built" (Callon, 1986, pg.15). The network has strong solidity, it works, and it is true. However, this network of actors, relationships, and alliances can be contested at any time. Dissidence can destabilize the facticity of the network.

Studying an act of *dissidence* involves questioning where controversies come from, how they occur, and how they are ended. At any time, any actor within the network could break from the network and it could cease being defined by its identity within that network. If an actor is defined in the network by a particular action, and it discontinues that action, it is no longer stably identified within the network. The moments of *interessement* and *enrollment* have failed, and dissidence has occurred. The network is no longer stably connected, the actors are not stably identified, and the alliances may break down. The identity of that actor may later be re-stabilized in the same network, or it could be *interessed* and *enrolled* into another network where it maintains a new identity. It is not until the spokespeople of the network are deemed to be beyond question that closure of the controversy occurs, and the research becomes fact.

### 1.7.3. The Final Tools in the Tool Kit

There are some final terms and concepts within ANT that I must explain as they are valuable to the analysis in this paper. The first is what is meant by a scientific article. By this, I mean what type of writing can be considered a scientific article? This is important to understand in order to justify the use of the particular scientific article I describe in the analysis. From this, I must also describe terms attached to elements that can be found within scientific writing. These include *inscription devices, stacking, modalities*, and *black boxing*. First, I begin by describing the basic idea of a scientific article, inspired by the work of Latour and Fabbri (1977; 2000). A scientific article is not a text that transmits information, it is instead a text that acts (2000, pg.122). It attempts to convince the reader of something. This type of article is written in a way that hopes to convince the reader that the proposition argued within is a true proposition (1977, pg.81). The scientific article achieves this by arguing from authority. This means the text brings in allies and refers to former texts (Latour, 1987a, pg.31,33) in order to demonstrate agreement

among many, thus garnering the article authority with which it can speak. Latour and Fabbri (2000, pg.119) discuss how scientific articles are riddled with references. Articles reference the institution that made the research possible, the sources of funding, the discipline in which the author works, former research, the instruments used in the research, and more.

A scientific article, however, acts within limitations. It can only divulge certain information to the reader. The journal in which the article is published places limits on how long the article can be and what type of information needs to be present in the article, and therefore limits how much information about the scientific process and the laboratory work can be seen by its reading. As I study the work done in the Steinberg and colleagues laboratory, I am studying what the published article allows me to see. I am constricted by its restraints. Different information is gleaned from watching scientific work being done in the laboratory than from reading the text. Therefore, it is not the researchers, or the laboratory, but the article that talks. The article is the actor that becomes a spokesperson for all of the actors in the laboratory, including Steinberg and colleagues.

I describe how instruments are referred to in scientific texts by describing them as *inscription devices* and defining the term *stacking*. When analysing a scientific article, one can study the final product – the published paper – and the different tools, knowledge, experiments, and more that went into producing the scientific proposition of interest (Latour, 1987b). This is studying the methods used by the scientists. Figures are taken from instruments in the laboratory. Instruments, also referred to as *inscription devices*, are any set-up that provide a visual display in a scientific article (Latour, 1987b, pg.68). *Inscription devices* are instruments that can transform some substance in the laboratory into a diagram or chart in a paper (Knorr-Cetina, 1995, pg.151). Therefore, information can be put into an MRI machine which will give a particular output. That

output will be interpreted by the researcher and displayed in their article. This is part of the *stacking* process whereby pictures, numbers, and figures provide a visual representation of a statement. *Stacking* shows the reader what data, figures, numbers, or other *inscription device* output the article's statements are tied to (Latour, 1987a, pg.50). These visuals are the end result of the laboratory process in which instruments, tools, knowledge, and more were mobilised in studying a particular issue. So, in reading a scientific article, the audience can get a sense of the process through which the scientific proposition was produced.

A second type of reference that can be made in a scientific article is to previous research conducted by other scientists. The way in which the work is referenced is called a *modality*. *Modalities* are an important piece of the references made in scientific articles. They are statements that either make modifications to, or qualify, other statements (Latour, 1987a, pg.23). They are modifiers of statements that make note of how fact-like the statement is (Knorr-Cetina, 1995, pg.151). *Modalities* can be positive, or downstream, in that they lead the reader away from their conditions of production (Latour, 1987a, pg.23). This type of *modality* enhances the "fact-like status of the statement" (Bertotti & Miner, 2019, pg.247). A positive *modality*, therefore, speaks about another statement, study, or proposition as a certainty (Latour, 1987a, pg.23). This type of reference adds solidity to the work that is being brought in and referenced in the scientific article. There are terms that indicate a reference is in fact a positive *modality*. These are called *boosters* and can be terms such as 'extremely', 'several studies', or 'clearly' (Bertotti & Miner, 2019, pg.247). These boosters enhance the certainty and acceptance of a statement being referenced.

On the other hand, negative, or upstream, *modalities* lead to uncertainty and lead to the conditions of a proposition's production (Latour, 1987a, pg.23). These *modalities* detract from

the facticity of a statement (Bertotti & Miner, 219, pg.247). This type of sentence can call into question the findings, making the statement more of an artifact, in which case it loses solidity (Latour, 1987a, pg.23). There are tell tale signs of negative *modalities*, which Bertotti and Miner (2019, pg.247) call *hedges*. *Hedges* can be terms such as 'may', 'could', or 'it may be unlikely'. These reduce the certainty of the statement. Every scientific article references previous work to place the current work into context, and the *modalization* of other works can shed light on what findings are considered more factual than others within the text being studied. Positive *modalities* refer to work that is considered factual by the authors of the text, and therefore that are being brought in to reinforce the current work.

When a paper is referred to with positive *modalities*, when it is used and borrowed without any *hedges* or qualifications, then its methods and statements turn into facts (Latour, 1987a, pg.41). This means that a *black box* has been created. The more people believe it and use it as fact, the more it is black boxed (Latour, 1987a, pg.41). *Black boxing*, therefore, is the process through which a technology or a statement is given authority (Graham, 2009, pg.387). The more people who confirm the technology or statement, the more black boxed it is, and the more authority it has garnered. If something is black boxed and used in a paper, that paper becomes more difficult to contradict or counter (Latour, 1987b, pg.80). In order to refute the paper, one would need to go back and prove that those black boxed statements were also false. Therefore, using black boxes in research can be a method of ensuring that the current research gains facticity, as it is more difficult to oppose research that has many black boxed allies than to oppose research with no black boxed allies. *Black boxing* is a process that occurs throughout scientific articles over time.

With all of these tools and concepts at its side, a scientific article seeks to convince. Scientific articles are riddled with many types of references which seek to strengthen the proposition concluded in the text. However, one final key component of a scientific article is the application of caution or limitations. As soon as the article gains authority, gains credit, through its references, it is assigned limitations (Latour & Fabbri, 2000, pg.130). The article does not dwell on its assertions, but rather provides caution to its findings so as to not overstate its own certainty. It will be the job of other scientific texts to refer to it through positive *modalities* for its certainty and solidity to be confirmed.

### 1.7.4. Studying Translations in the Neurologization of Adolescence

This paper seeks to describe the network of connections involved in the Steinberg and colleagues (2008) scientific article. Through this description, it will be clear how the paper, and the proposition about adolescence concluded from the paper, gain solidity and how this gaining of solidity neurologizes the adolescent entity. I present my take on work from Callon and Latour, however, I also have other allies in my research. While the analysis makes use of terms and concepts specifically from Callon and Latour, it is important to refer to some allies and texts that have inspired my take on ANT. Some of these include M. Dufresne's (2015) "How Does a Gene in a Scientific Journal Affect my Future Behavior", R. Gorur's (2011) "ANT on the PISA Trial: Following the statistical pursuit of certainty", and M. Dufresne and D. Robert's (2017) "La Biographie d'un gène". These allies have done research within ANT that helped further my understanding of ANT and helped develop the analysis presented in this thesis.

The analysis is broken up into three parts, each of which corresponds to one of Callon's three types of translations. The first looks at Callon's second type of translation, the translation

that occurs within the laboratory, using *inscription devices, stacking, black boxing* and more (Callon, 2003, pg.59). In this part, I describe the published paper scientific text from Steinberg and colleagues (2008). I look at all of the actors involved in the network, and the moments of translation moved through in order to problematize and mobilise allies. I describe how the scientific article is solidified and how this gaining of solidity neurologizes the adolescent entity.

The second part of the analysis looks at Callon's first type of translation, the process of translating an entity from the outside world to the laboratory (Callon, 2003, pg.59). In this part, I describe the decision by the researchers to separate the actors of sensation seeking and impulsivity rather than conflating them. I look at the moments of *interessement* and *enrollment* specifically, to understand how the adolescent was translated from the outside world into the laboratory through the definitions and identities of these actors. This, again, provides a description of how solidity is ensured and the adolescent entity continues being neurologized by the research.

The last part of the analysis then looks at Callon's third type of translation, translating from the laboratory back to the outside world (Callon, 2003, pg.59). I describe how the scientific article from Steinberg and colleagues (2008) was translated from the laboratory to the legal world. I delve into the use of the Steinberg and colleagues (2008) paper in two United States Supreme Court cases. I illustrate the *modalities* and allies involved in the court opinions, the oral arguments, and the supporting documents submitted by the AMA and APA for the two cases. This provides a description of how the research gains solidity and further neurologizes the adolescent entity outside the scientific realm of the laboratory. By the end of the three parts of the analysis, it should be clear that, throughout all three translations, the actor-network that makes up the adolescent entity becomes more interconnected and gains strength. The fact

produced by Steinberg and colleagues (2008) about adolescence maintains and gains solidity while also neurologizing the adolescent entity. However, before I move into that description, I discuss two criticisms of ANT that are relevant to this project and how ANT is the most appropriate theoretical tool despite these criticisms.

## 1.8. Criticisms of ANT

An explanation of the theory employed in the analysis would be incomplete without acknowledging some criticisms of that theory. In using any theory to study a research problem, one must recognize relevant critiques of the work. There are two main criticisms of ANT that I will focus on here. They are relevant to my project and to ANT in general. I also do this in order to explain why ANT works for my project despite these criticisms. The first criticism I look at is the problem of non-humans and their associated agency. This is relevant as it relates to and plays a role in the 'science wars'. The second criticism is focused on the purpose of research and the difference between explanation and description.

### 1.8.1. The Problem of Non-Humans and Non-Human Agency

One prominent critique of ANT that has surfaced revolves around Latour's double symmetry – the way in which non-humans are conceptualized and how those non-humans are given agency (Bloor, 1999, pg.84; Sayes, 2017, pg.295). The criticism focuses on how non-humans are designated agency and how this has added to the conversation of the 'science wars' (Martin et al., 2011, pg.16). According to Schaffer (1991, pg.182), attributing life, will, and purpose to inanimate objects and matter, as well as attributing human interests to non-humans is said to devalue scientific experiments. Therefore, Schaffer perceives experimental work and labour to be heavily neglected when non-human actors in a network are allotted agency. In this

way, many people have taken the work of actor network theorists and other sociologists to be a harsh criticism of scientific discourse and inquiry (Latour, 2004). In other words, it is perceived to take on a critical view of science with the goal of criticizing or devaluing scientific practice. Some have used the arguments of ANT in an attempt to dismantle the scientific evidence surrounding issues like climate change (Latour, 2004, pg.236). While the aim of science studies is to democratize science and not to criticize, it has nonetheless had this effect for certain individuals. This is a critique of ANT that needs to be taken seriously. This project will therefore be careful in how the scientific process is described. I have chosen the term production, rather than fabrication or construction to avoid any misunderstanding of the purpose of the project. I do not describe the scientific process as one of fabricating statements, but rather as producing facts. The term 'produce' connotes a more neutral position than the other options available such as fabricate or construct. The goal is not to say that statements developed in science are socially constructed or not real, but to democratize the process of science so that there is a better understanding of how facts come to be produced from science. I am interested in how facts are produced from social, political, and scientific relations inside and outside the laboratory that build a strong actor-network.

### 1.8.2. The Problem of Explanation versus Description

There is a second relevant criticism of ANT, and that is the problem of explanation versus description. The criticism here, is that describing associations within a network is just that, a description (Latour, 1996, pg.10). This means it does not offer any explanation for the phenomena being studied. This is important as many researchers require or desire some kind of explanation. Therefore, if I am using ANT and simply describing the actor-network, then I am not producing important research. However, Latour (1996, pg.11) has countered this criticism

well. He says that actor-networks connect with each other and this connection provides an explanation of themselves. Each network grows, and when it grows, it binds to the explanatory resources around it. There is no need to move outside of a network to attach some kind of explanation, rather it is simply necessary to extend the network further to grow more explanatory resources. In viewing the research this way – the explanation as tied to the network itself – ANT does not abandon explanation as the purpose of research. The question of having to explain outside of the network is dissolved (Latour, 1992, pg.4). The network becomes more of an explanation of itself the more it grows (Latour, 1996, pg.11), therefore a description of the network inherently provides the explanation for the network's strength. For this reason, I do not find this criticism compelling enough to abandon the use of ANT. In fact, it provides more of a reason to study this particular topic in this way.

As I provide a detailed description of the neurologized adolescent actor-network, the explanation of its strength as a fact will unveil itself. Therefore, ANT is best thought of, not as a theoretical explanation to be attached from the outside, but as a tool kit that can be used to aid in the description of an actor-network from the inside. The following chapter is my analysis of the Steinberg and colleagues (2008) scientific article. I aim to describe how the research maintains and gains facticity while neurologizing the adolescent entity. This is described in three stages, using Callon's three types of translations and with help from some other ANT concepts and terms. This will describe the neurologization of the adolescent entity actor-network.

# CHAPTER 3: NEUROLOGIZING ADOLESCENCE IN SCIENCE AND LAW

In this chapter, I aim to democratize science through a detailed description of the scientific process of fact production. The aim of this work is not to tear down or criticize science, but rather to provide a description of how the work being done in science progresses and gains facticity. Scientific work is fascinating, so the purpose of this analysis is to bring to light all of the work being done inside and outside the laboratory, from all of the actors involved, to produce facts and knowledge.

The aim of this analysis is to explore how a scientific proposition is produced in the laboratory, and how that proposition is solidified in the legal world. This will involve following the transformation of a social entity – that of adolescence – into a scientific fact. As well, as the adolescent entity is translated into a scientific fact, it goes through a process of neurologization. That is, it becomes a behavioural phenomenon explained and defined through neuroscience. The neurologization of adolescence in science and law is demonstrated through the case study of one research paper written by Steinberg and colleagues in 2008. I will illustrate the actor-network involved in the production of one statement about adolescence that emerges from the scientific article. That statement gains solidity in many different ways that will be discussed, including in the decision to rely on black boxed neuroscience research and its use in two important United States Supreme Court decisions regarding juvenile justice sentencing. It will be clear that as the statement produced by the Steinberg and colleagues (2008) article gains solidity, the adolescent entity becomes neurologized.

The simultaneous progression of these two things – the statement gaining solidity and the adolescent becoming neurologized – is presented through Callon's (2003) three types of translations. The first translation consists of translating an entity from the macrocosm of the outside world to the microcosm of the scientific laboratory. The second translation is what happens inside the laboratory. It focuses on the inscriptions, the measurement devices, and more. The final translation is from the microcosm of the science laboratory back to the macrocosm of the outside world. I will start with the second type of translation as I describe the actors involved in the production of the statement concluded from scientific work in the laboratory. I then describe how the adolescent, as an entity, was brought into the lab from the outside world as I provide insight on one decision made by the researchers regarding the problematization of the actors of sensation seeking and impulsivity. Finally, I look to the third type of translation as I describe how the statement moves beyond the laboratory to the United States Supreme Court and how this movement solidifies the facticity of the neurologized adolescent entity.

Each of these translations lend to the growth of the adolescent entity actor-network. I use the comparison of a molecule to provide a visual representation of this actor-network. As we move along each translation, we are building the adolescent entity molecule by describing more actors within the network. An illustration of the adolescent entity molecule is provided in Figure 1 of the Appendix. Each ally, *inscription device*, and actor in the network represents one atom in the molecule. The connections between the actors are represented by bonds between the atoms. This will hopefully provide a visual aid in understanding how the actor-network grows through each translation.

## 1.9. Upstream Analysis One: Building the Molecule

The first step in describing the facticity and neurologization of adolescence in science and law is to move upstream – to look towards the production of the research by building the molecule – to describe the actors in Steinberg and colleagues' (2008) research that led them to their conclusion about what it means to be an adolescent. Each actor represents an important component of the molecule, connecting to other actors and stabilizing the molecule. This building of the molecule is a study of Callon's (2003) second translation, the movements and displacements that occur within the science laboratory in order to produce a statement in a scientific text. This is the beginning of describing the translations in order to demonstrate facticity in science. Each actor that binds in the molecule lends solidity to the final statement. This is also the first step in defining adolescence through neuroscience. From the field of neuroscience comes an important set of actors *enrolled* into the actor-network molecule, allowing the adolescent to be defined in this way and thus setting off the neurologization of adolescence.

The main focus of Steinberg and colleagues' (2008) research is explaining risky behaviour observed throughout adolescence. My intention here is to describe the social production of the scientific work presented in the text and the production of the final statement about adolescence. This will demonstrate how the social production of scientific work can lend solidity to the statement. My description focuses on an article written by Steinberg and colleagues (2008) titled "Age Differences in Sensation Seeking and Impulsivity as Indexed by Behavior and Self-Report: Evidence for a Dual Systems Model", published in *Developmental Psychology*. This is the case used for the exploration of the production of scientific facts in the scientific domain and their subsequent solidification in the legal domain.

This scientific article was chosen for many reasons. First, the article is prolific in the scientific world. Since 2008 it has been referenced by 762 other scientific articles (according to the Scopus database). I looked through the abstracts of these articles to have a general idea of how they may have been citing the Steinberg and colleagues (2008) text. The majority of these abstracts told me that they were building off of knowledge produced in the text, and therefore implies positive *modalization* of the work. This means that, for the most part, the text is being referenced as factual, as knowledge to be built upon rather than knowledge to dismantle. Thus, other researchers have *black boxed* this work. Along this same reasoning, the head author, Laurence Steinberg, is well known in the field of adolescence. He has written many books and published many articles on the topic, meaning this paper was written by experts in the field being studied. The text itself is intriguing as Steinberg and the other authors are researchers in the field of adolescence and psychology, however research from other fields like biology and neuroscience are brought into the text. There is a combination of knowledge from multiple disciplines being combined in this one paper. Finally, and most importantly, the text was referenced in two United States Supreme Court cases. This makes it possible to describe the translation of the scientific statement outside of the laboratory and into the courtroom.

The following section will focus on the selected text, the actors involved in producing the statement, and how this process reinforces the solidity of the statement while neurologizing the entity of 'adolescence'. I provide a brief summary of the article and the main statement about adolescence produced from the research. Then, I describe each actor involved in the production of the scientific text and the impact each had on the solidity of the statement. I conclude this section by describing how the statement gaining solidity leads to the adolescent actor-network molecule becoming neurologized.

### 1.9.1. Steinberg and Colleagues' (2008) Laboratory – Describing the Molecule

The Steinberg and colleagues (2008) article analyzes findings from self-report and behavioural task measures of sensation seeking and impulsivity in order to provide evidence for a dual systems model of adolescent behaviour. This theoretical model is based on neurobiological evidence of the development of the brain from childhood, through adolescence, and into adulthood. The model proposes that adolescence consists of a sharp increase in sensation seeking, followed by its subsequent decrease in late adolescence, while impulse control develops more slowly throughout this time period. This leaves a period of vulnerability, where adolescents are more likely to partake in risky behaviours and activities (see Figure 2 in Appendix for visual representation).

The dual systems model makes use of neuroscientific evidence to posit that risky behaviour emblematic of adolescence is brought about by the interaction between two separate brain systems. The first neurobiological system is the socioemotional system which is localized in the limbic and paralimbic areas of the brain and includes the amygdala, the ventral striatum, the medial prefrontal cortex, the orbitofrontal cortex, and the superior temporal sulcus (Steinberg et al., 2008, pg.1764). The second system is the cognitive control system which is made up of the lateral, prefrontal, and parietal cortices as well as the connecting areas of the anterior cingulate cortex (pg.1764). Each neurobiological system is believed to be responsible for certain behaviours. The socioemotional system is said to be responsible for emotion response behaviour, while the cognitive control system is responsible for the development of cognitive decision making. These two systems are believed to develop along different timelines from childhood to adulthood. According to the dual systems model, risk taking behaviour throughout adolescence is brought about through rapid, dramatic increases in the activity in the socioemotional system

(pg.1764). This increase in dopaminergic activity begins around the start of puberty and presumably leads to developmental increases in sensation seeking or reward seeking behaviour. This increase in activity occurs before the cognitive control system is fully matured and connected to the socioemotional system. This maturation of the cognitive control system occurs gradually throughout the course of adolescence and allows for improved self-regulation and impulse control. The temporal gap between the activation of the socioemotional system and the gradual development of the cognitive control system generates a period during adolescence of heightened vulnerability to risky behaviours. This characterization of adolescence as a period of heightened vulnerability to risk taking is the main takeaway from the Steinberg and colleagues (2008) text and forms the basis of the analysis in this thesis. The statement about adolescence produced from this research, the one that will be followed throughout this paper is as follows: "Heightened vulnerability to risk taking in middle adolescence may be due to the combination of relatively higher inclinations to seek excitement and relatively immature capacities for self-control that are typical of this period of development" (Steinberg et al., 2008, pg.1764).

The published paper consists of four sections, each of which serves a purpose in the gaining of solidity for the final published statement about adolescence. The first section consists of a review of the literature. They pull from neuroscience, biology, and psychology to support their research. This literature provides the justification for their project. The second section consists of their methods. This includes participants, procedure, and measures. They recruited 935 individuals to participate. The researchers also included four measures: two self-report measures and two behavioural measures. The Zuckerman Sensation Seeking Scale (SSS) (Zuckerman et al., 1978) was used as a self-report measure of sensation seeking and the Barratt Impulsiveness Scale (BIS) (Patton et al., 1995) was used as a self-report measure of impulsivity.

The researchers employed the Tower of London game as a behavioural measure of impulsivity and the Stoplight Game as a behavioural measure of sensation seeking. These are discussed in detail later. The results section consists of *stacking* in order to provide visual representations of what is being said by the words in the text, and this section seeks to convince the reader of the text's findings. The final section is a discussion of the results including what the results mean, why they are important, and the limitations of the paper.

The Steinberg and colleagues (2008) text supports the claims by combining the neurobiological evidence from previous studies, as well as results from the self-report and behavioural task measures of sensation seeking and impulsivity. The text assures the reader to have confidence in the validity and strength of the findings, while also being careful to not overstate the results. Weaknesses in regard to the Stoplight game are discussed, while also highlighting the strengths of the sensation seeking self-report questionnaire. The text also states certain gaps in the research (how social context might influence sensation seeking; individual variations in sensation seeking and impulse control; how contextual factors influence development of sensation seeking and impulse control, and the neural underpinnings of these processes) where those interested in the physical and psychological well-being of young people could conduct future studies.

The researchers were interested in the pattern of impulsive behaviour and the pattern of sensation seeking behaviour throughout adolescence, and how these relate to puberty. They concluded that impulsivity declined linearly from childhood, through adolescence, into adulthood. Impulsivity was also unrelated to pubertal status. The researchers also concluded that sensation seeking followed a curvilinear and linear pattern, with an increase from childhood into adolescence and then a linear decline from adolescence into adulthood. Pubertal status was

correlated with sensation seeking. The text makes use of these results to demonstrate behavioural evidence in support of the neurobiological dual systems model of adolescent behaviour. The findings are believed to confirm the knowledge about risk taking behaviour in adolescence that was proposed based on the neurobiological evidence of the dual systems model.

The goal of the research from Steinberg and colleagues (2008) was to provide behavioural evidence in support of the dual systems model through a combination of self-report and behavioural measures over a large age range of 10 to 30 years of age. The researchers subjected the participants to a two-hour assessment consisting of a demographic questionnaire, an assessment of intelligence, a self-report measure of pubertal status, impulsivity, and sensation seeking, a test for working memory, and computerized tasks to measure impulsivity and sensation seeking. The researchers combined evidence from the fields of neuroscience, biology, and psychology in order to demonstrate the validity of the proposed model of adolescent development. What follows is a description of each part of the text and how each actor within those components of the research plays a role in producing the statement, ensuring its solidity, and neurologizing the adolescent.

### *Justifying the Project*

The first component within the article I discuss is the way in with the project is justified. This includes many actors which come together to explain to the reader the purpose of the research and the way in which the research will contribute to knowledge on the chosen topic. Latour and Fabbri (2000) discuss how every text seeks to convince the reader of something. They act solely to convince. For instance, this article acts to convince the reader that adolescence is a period of heightened vulnerability to risk taking. Each text is different in that it is trying to convince the reader of something different, but they all share this one, general goal. Scientific

texts differ from other texts in the way they seek to convince. Scientific texts seek to convince "…by developing layers of texts consistent with one another which serve as mutual referents" (Latour & Fabbri, 2000, pg.122). Scientific texts bring together multiple actors that agree with one another in order to convince the reader of their statement. This component of the article contains a few actors that are *enrolled* in the actor-network in order to justify the project, the first of which is funding.

Funding provides the science laboratory with the money required to conduct the project. Before the project has even started, the researcher must *interesse* an actor to invest in the project. By gaining funding the researchers have *problematized* their research in a way that stabilizes and solidifies the project. The Steinberg and colleagues (2008) article brings in funding from the John D. and Catherine T. MacArthur Foundation Research Network on Adolescent Development and Juvenile Justice (FRNAD)(pg.1764). The researchers were able to impose and stabilize the identity of this particular actor in its *problematization*. Therefore, even before the research began and before the reader begins reading the article, there is reference to one actor connected in the molecule or statement about adolescence. In the process of gaining funding, the researchers would have had to *problematize* their research in a way that identified the goal of the funding institution – why they would be interested in providing money for the project. Based on the institution, we can see that they might have a vested interest in the topic at hand, and this would provide the institution with a reason to fund the project. While the Steinberg and colleagues (2008) research does not focus on juvenile justice, it does revolve around adolescent development. The fund could be *interressed* into the actor-network through this. The fund could then hope that the research would develop knowledge on adolescent development that is useful

in furthering progress within the field of juvenile justice. Without this funding, the research would not continue. This foundation is the first actor that we see in the actor-network molecule.

A second group of actors in the network of the molecule becomes clear in the first section of the main text. This is the review of the literature and the justification of the project ranging pages 1764 to 1766 of the text. Almost every single sentence here references an outside text, another source of information. The researchers reference previous work in neuroscience, on puberty, on sensation seeking, and on impulsivity. They are laying the groundwork for developing their justification of the current project. In addition, every time they reference, they are bringing in friends, making it more difficult to refute what they are saying. On page 1764 the text reads "A growing literature…indicates that the remodelling of the dopaminergic network involves an initial postnatal rise…". This is followed by a reference to three other scientific articles: "Sisk & Foster, 2004; Sisk & Zehr, 2005; Teicher, Andersen, & Hostetter, 1995". The Steinberg and colleagues (2008) text is building knowledge around the topic of adolescence and doing so by bringing in allies. To argue against this paper, one needs to demonstrate that the friends referenced in the text are incorrect. The scientific article is bringing more actors into the network, increasing the solidity of the statement.

It is not simply that this section is riddled with references, but that the researchers have *enrolled* specific types of actors from specific scientific disciplines. The authors rely quite a bit on neurobiological evidence that the dual systems model they are supporting is valid. Five of the six researchers on the team work in psychology departments, however the research they rely on most is neuroscience. This could be for many reasons, but by demonstrating that the psychological research agrees with research from the field of neuroscience, the text gains a new, and strong, ally. Science itself has a cultural authority (Aronson & Cole, 2009), but neuroscience

has become a large influence over the past few years on how society defines personhood (Schneider & Woolgar, 2015). The MRI specifically, as a technology, has been identified as revolutionary (Graham, 2009, pg.377). The technology has gained legitimization through *black boxing* which gives it authority in the field (Graham, 2009, pg.378). From examining the articles referenced in the text, most of the neuroscience research cited in the Steinberg and colleagues (2008) text involves the use of MRIs, thus providing more legitimation to the references already in use. So, bringing in actors that provide this neuroscientific background to explain and justify the research, provides strength to the actor-network being built. It may be more difficult to contest with solidified methods in neuroscience such as fMRIs, thus providing the published text with solidity. The cultural authority of both neuroscience and MRI technology ensures that brining these allies into the molecule will strengthen the solidity of the statement about adolescence. The researchers are spokespeople for the adolescent actor-network molecule, and in this process of referencing other scientific articles, they mobilize the very strong ally of neuroscience.

Mobilizing allies from one field of study to provide background on the topic would be strong, however bringing in even more friends from different fields provides even more to contend with if one wants to dispute the work. The researchers bring in more actors, some from the field of biology that study puberty and some from the field of psychology that study sensation seeking and impulsivity (pg.1765). Research from each discipline is woven together with the next in a way that demonstrates their agreeability. The text begins with references to neurobiological evidence on page 1764. Then, information on how puberty interacts, from the discipline of biology, is intertwined. Next, on page 1765, the text turns to behavioural research. This is intertwined with the connections of the behavioural research to puberty. The text then

discusses how these different disciplines play off of one another. The references are *stacked* in a manner that provides the reader with an understanding that each discipline is in agreement with the current state of knowledge on adolescent development. Because each discipline brings in a different type of knowledge, the references are not *stacked* directly on top of each other. Rather, each reference adds to the previous new information that builds a more complex picture.

The actor-network molecule becomes larger as these connections are built, and the molecule becomes stronger as these actors are referenced in a way that solidifies the statement. The authors do not use diminishing *modalities*, or *hedges*, when referencing the work. Rather, they use *modalities* that enhance the acceptance of a statement such as, "Neurobiological evidence…is rapidly accumulating" (pg.1764) and "…there is good evidence that…" (pg.1765). The statements are *boosted*. The friends being brought in are positively *modalized*, so as to add certainty to the research. They are not looking upstream or questioning these actors, but instead *problematizing* them in a way that *interesses* them in the project. Their identities within the project are solidified. They are identified as allies mobilized to justify the research and make it more difficult to contest. They become part of the actor network, connecting with each other and with the work done to produce the scientific article.

The scientific article positively *modalizes* the evidence on which their statement rests in order to build an understanding of the current state of knowledge on adolescent behaviour. However, in order to justify the current work, the texts must also demonstrate that there are gaps in the knowledge base. The text must be careful in its convincing. It must convince the reader that the knowledge that is being built on is accurate, while also convincing the reader that there is still information that is not known. The researchers discuss that this text is the first to "…measure impulsivity and sensation seeking independently…", to "…span a wide enough

range to examine the developmental course of each phenomenon from preadolescence to early adulthood…", and to use "…both self-report and performance measures" (pg.1766). So, while the dual systems model is not new, and the hypothesis on adolescent development is not new, this text is the first to bring all of the pertinent knowledge together to form a coherent image of adolescence. Any reader of this text may now be more compelled to believe the statement as fact because it is tying together so many pieces of evidence that are all in agreement.

Through the positive *modalizations* of the literature and the reviewing of the gap in knowledge being filled by the project, the statement gains solidity. Connections are being made with other actors and allies who help to solidify the statement and make it more difficult to contest. These allies are *enrolled* in the network as actors who provide knowledge on the dual systems model and adolescent development. The network of connections does not end here however, as the proposition gains more solidity through the *interessing* of participants, as well as *inscription devices* and instruments used in the laboratory.

### *Enrolling Actors of Measurement*

In order to conduct this research, the authors needed participants, specifically participants between the ages of 10 and 30. Not only did the *problematization* have to establish the identity of the participants in a way that *interessed* them and stabilized them in the research, but also the identity of the guardians of some of the participants. This took place in two steps. First, newspaper advertisements and flyers were sent out. Then, anyone interested was asked to call the research office and the research was further described over the phone. The participants had to first be enticed enough by the flyer or newspaper advertisement to call the office, then they had to be convinced over the phone that the research was worth their time. The researchers had to

*problematize* the research and the role each participant would have in the research in order to *interesse* them.

This recruitment method was effective at acquiring almost 1000 participants. Steinberg and colleagues (2008, pg.1766) recruited 935 individuals between the ages of 10 and 30 from Denver; Irvine (California), Los Angeles, Philadelphia, and Washington, DC. A relatively equal number of participants were recruited from each location. The participants were 49 percent male and 51 percent female, with 30 percent of participants being Black, 15 percent Asian, 21 percent Latinx, 24 percent White, and 10 percent other (pg.1767). The sample consisted of predominately working and middle class individuals. These individuals were divided into seven age groups presented in the following table:

| Age Group | Number of Participants |
|---|---|
| 10 to 11 years old | 116 |
| 12 to 13 years old | 137 |
| 14 to 15 years old | 128 |
| 16 to 17 years old | 141 |
| 18 to 21 years old | 138 |
| 22 to 25 years old | 136 |
| 26 to 30 years old | 123 |

Participants were given reward incentives to complete the entire assessment in the study, thus providing incentive to become part of the network. These particular actors were

*problematized* as participants helping to understand and define adolescence as a unique period of development. While this was their identity within the project, this alone may not have enticed them to participate to their best ability. The reward incentive was a measure used to ensure the participants remained *enrolled*, to ensure they did not become *interessed* in a different network. If perhaps, the participants were not given a reward incentive, their focus may not have been entirely with the assessments, meaning that their ties to other networks would not have been severed. The research required that the participants be *enrolled* in the network for the full two-hour assessment. They become integral actors to the solidification of the statement and to neurologizing the adolescent entity. Without participants, the research stops here. With participants, the research continues to thrive, and the network of connections continues to grow longer and stronger.

Once the participants were *enrolled*, they were subjected to an assessment with many *inscription devices*. The first set of *inscription devices* involved tests of control. This involved measuring demographics, intelligence, pubertal status, and working memory. Some of these were basic control variables. The researchers are ensuring that they test sensation seeking and impulsivity across a wide range of intelligences and demographics, as well as individuals at different stages of pubertal development. This is an important step within the correspondence model of science, which these researchers are enacting. This step protects the research in advance, ensuring that it cannot be easily dismantled. Simple explanations for the research not being solid enough, such as having only measured the phenomena in females, are avoided by measuring these control variables in advance. This step allows the scientific article to pre-emptively defend the actor-network molecule from attacks in the future so as to ensure its solidity. By attacks, I mean only other researchers attempting to dispute the findings. Measuring

the control variables provides solidity to the research because it eliminates any trivial explanations for findings that may be unrelated to the hypothesis of the dual systems model.

Other control variables, such as working memory, are measured for more specific purposes. According to the researchers, the behavioural measure of impulsivity – the Tower of London test – is known to involve impulse control as well as working memory (pg.1768). By measuring working memory in advance, future arguments that the tests measured a combination of impulsivity and working memory, rather than impulsivity alone, are prevented. This provides the research with solidity because secondary explanations for the results from the *inscription devices* are invalidated. These *inscription devices*, however, are only conducting tests of control. If the tests stopped here there would be no meaning to the study, no conclusion to be drawn about adolescence. Since purpose of a scientific text is to convince with layers of references, *inscription devices* that provide for tests of convincing are required.

Since the purpose of the scientific text is to convince (Latour & Fabbri, 2000), it is necessary that there be tests of convincing. Therefore, the project requires *inscription devices* that provide for tests of convincing, tests that will produce results from which conclusions can be drawn. Within this research sensation seeking and impulsivity are defined as two separate constructs, a decision that will be discussed in further detail in the section two of this analysis. Two types of *inscription devices* were used to measure these two behavioural characteristics. The first inscription device is a self-report questionnaire. Each participant had to fill out a questionnaire about their behaviour as it related to impulsivity. The Barratt Impulsiveness Scale (BIS), Version 11 (for a full description of the scale see Patton et al., 1995) was used to measure impulsivity levels of each participant. A decision was made to use three 6-item subscales: motor impulsivity, inability to delay gratification, and lack of perseverance. The respondents had to

answer each statement by choosing whether the statement applies to them never/rarely, occasionally, often, or almost always/always. This particular *inscription device* provided self-reported impulsivity data for each participant.

This actor in the network, just as the previous actors, had to be *problematized* in a way that stabilized its identity within the project. The researchers only used those subscales in the BIS which corresponded with impulsive behaviours. They removed any subscales that were seen to measure sensation seeking according to its stabilized definition within the project. So, any subscales that measured a "…tendency to seek out novel…experiences, and the willingness to take risks in order to attain them" (Steinberg et al., 2008, pg.1765), were removed. In this sense, the researchers used what I will call the BIS minus, that is, the BIS excluding three of its six subscales. The subscales not used were that of attention, cognitive complexity, and self-control (pg.1768). The statements corresponding to these subscales such as "I am restless when I have to listen to people" and "I am a great thinker" (pg.1768) were removed from the BIS before being administered to the participants. Here, the researchers had to sever any ties the BIS had with sensation seeking, attention, cognitive complexity, and self-control, to be able to *interesse* it as an actor whose role in the network is to measure only impulsivity. By severing these ties, the self-report questionnaire *inscription device* is *enrolled* as an actor within the network that does not measure these four characteristics and that does measure impulsivity.

The subscales that were used measured motor impulsivity, the inability to delay gratification, and a lack of perseverance (pg.1768). These include items such as "I act on the spur of the moment" and "It's hard for me to think about two different things at the same time" (pg.1768). The Steinberg and colleagues (2008) article is not calling into question the validity of the test they are using. However, the network requires that this test, this *inscription device*,

become an actor in the network and help to solidify the facticity of the network. They are not aiming to move upstream to its production, but rather to *modalize* it in a way that moves downstream. Because it is known that the three eliminated subscales measure behaviours related to sensation seeking and planning and thinking carefully, their ties to the *inscription device* must be severed so that this instrument can play a critical role in the actor-network, as a measure, solely, of impulsivity. Only the three subscales that are maintained in the BIS for this study measure "deficiencies in response inhibition" (pg.1765), corresponding to the article's definition of impulsivity. This decision makes the connection that the BIS has with the network even stronger. The BIS minus can act solely as a measure of impulsivity within the network and not be *interessed* in any other role.

This research *enrolls* a second self-report questionnaire, this time measuring solely sensation seeking. Self-reported sensation seeking was measured using the Zuckerman SSS (for a full description of the scale see Zuckerman et al., 1978). This survey was set up as a forced choice where each respondent had to answer which of two statements applied best to themselves. In other words, there was a choice between two behaviours and participants had to decided which described their behaviours best. Here, again, the researchers had to sever ties that the questionnaire had to a different behavioural characteristic than the one they are measuring. The researchers eliminated any items in the scale which measured impulsivity, such as, "I often do things on impulse" (Steinberg et al., 2008, pg.1768). They chose to keep the items which clearly designated thrill seeking or novelty seeking. Six of the 19 items on the SSS were kept for the purpose of this research. This version I will call the SSS minus, where many of the items were removed in order to sever the ties that the test had with other possible roles or identities. In order to *interesse* the *inscription device*, the researchers identified it as an actor in the network

responsible for measuring only sensation seeking. So, any part of it that could measure something else was eliminated. This stabilizes its identity within the network.

The SSS minus consisted of six items which were clearly measuring thrill or novelty seeking as in the definition of sensation seeking provided in this article. Statements such as " I like to have new and exciting experiences …even if they are a little frightening", "I'll try anything once", and "I like doing things just for the thrill of it" were maintained in the SSS minus to measure sensation seeking. The connection the test has to these types of items were maintained, while those that connected with the definition of impulsivity were severed. This ensured that the SSS minus would be *enrolled* in the network as an actor responsible for measuring sensation seeking only. Both *inscription devices* measuring self-reported behaviour required careful severing of ties to other identities or roles so that they could be *enrolled* in this network for their respective roles.

The second type of *inscription device* used in the research was a set of computerized behavioural tests. These were task-based measures that, again, measured both sensation seeking and impulsivity. The Tower of London (TOL) task was used to measure planning and executive function in order to generate an index of impulsivity. TOL is a computerized task in which the individual is shown images of "two sets of three coloured balls distributed across three rods" (Steinberg et al., 2008, pg.1768). One rod can hold all three balls, one can hold two balls, and one rod can hold only one ball. The first image presented shows the starting position of the balls on the rods while the second image shows the position in which the individual must get the balls to finish. The individual is told to move the balls in the first image to match the positioning in the second image, using as few moves as possible. The individuals were presented with five sets of four problems, where the first four can be solved in three moves, and each problem becomes

progressively more difficult, requiring more moves to complete, and ending with a minimum of seven moves to complete the problem. The individual is allowed to take as much time as they need to make each move.

The researchers were not interested in whether the participants could complete the task in the minimum number of moves. This task could be used to measure planning and executive function as this was the tasks original purpose (Steinberg et al., 2008, pg.1768), however these are not the behavioural characteristics that the *inscription device* was used to measure. Therefore, the TOL *inscription device* had to have ties to these other possible identities severed. The role of the TOL within this network is to measure impulsivity in each participant. Therefore, to *enroll* the TOL task as this actor within the network, data was only collected from one part of the task – the very first move made by each participant. This is what I term the TOL shortened (TOLs). The researchers recorded only the amount of time that elapsed, in milliseconds, from the presentation of the problem and the participant's first move. Rapid performance was linked to response inhibition difficulties, and therefore to more impulsive behaviour (pg.1768). So, shorter time to making the first move indicates more impulsivity. Since the researchers had already tested working memory as a control variable, this test was *enrolled* as a measure solely of behavioural impulsivity.

In order to *interesse* this instrument as an actor in the network, the researchers again had to sever ties. This time, however, they did not eliminate any pieces of the test. Instead, the researchers chose to add a control variable and to only take results from the beginning of the test. This allowed them to show whether the behavioural test was measuring only impulsivity, working memory, or impulsivity and working memory. In addition, it prevented the *inscription device* from measuring planning or executive function. Testing the control variable demonstrated

that working memory did not impact the results in a significant way. This test of control pre-empts criticism of the findings by providing evidence that the test was measuring solely impulsivity. By taking results only from the first move of the test, the *inscription device* is able to be brought into the network as an actor measuring only behavioural impulsivity.

This instrument becomes *enrolled* as a second actor in the network responsible for measuring impulsivity. However, the two instruments measuring impulsivity have slightly different stabilized identities. The BIS minus is identified as an actor measuring impulsivity based on the participants perceptions of themselves, while the TOLs is identified as an actor measuring impulsivity based on observed behaviour in a computerized task. Both have their individual role as actors in the network building the molecule in a way that will provide it with solidity. The severing of ties and measuring of control variables ensures that the statement, in the end, can only be denied if all of the other actors in the network are pulled away from their identified and stabilized roles.

The final *inscription device* is a second computerized behavioural task, this time measuring sensation seeking. This took the form of a computerized task called the "Stoplight" Game described on pages 1768 and 1769. In the computer simulation, the participant must drive a car to a distant location, where a party is taking place. The individual is informed that most participants can reach the location in under two minutes. On the screen the participant can see a clock, set to two minutes and thirty seconds, counting down the time. As the car approaches the location, the clock ticks down and party music becomes increasingly louder. The individual must drive through eight intersections, marked by a traffic signal, to reach the final location.

When the individual approaches each intersection, the traffic light may turn yellow. In this case, the individual decides whether to stop the car, by pressing the space bar on the keyboard and wait for the light to change to red and then to green again, or to attempt to go through the intersection. If the individual chooses to continue through the intersection the light may turn red and there is a chance that they crash into a car driving across the intersection at the same time. In the event the individual decides to go through the intersection and passes safely, they lose no time in arriving at the destination. Deciding to wait for the light to change back to green will cost three seconds of time. Attempting to go through the intersection and crashing costs the individual six seconds of time. The individual has to decide whether to continue through the intersection to attempt to save some time and risk losing twice as much time or wait and lose the smaller amount of time.

For this study, eight intersections were configured. The first intersection had a short latency between the appearance of the yellow light and the crossing vehicle, t=1,300ms. Almost every participant will crash at this intersection, even if they decide to brake. This intersection introduces the participants to the potential of crashing. The second, third, and fourth intersections have longer latencies between the appearance of the yellow and red light, t=3,000ms, 2,000ms, and 1,750ms respectively. Whether the participants decide to brake or drive through they cannot crash. The light remains green at the fifth intersection. This is said to break any established pattern the participants may have. The sixth, seventh, and eighth intersections have shorter latencies than the second intersection between the appearance of the yellow and red light, t=2,900ms, 2,450ms, and 2,000ms respectively. At these intersections it is possible to stop safely, but not to pass through the intersection without crashing.

This task involves making decisions in a condition of uncertainty, where one must decide between a low-risk and low-payoff choice or a high-risk and high-payoff choice. The researchers gathered data for all stops, except intersection five, on whether the participant stopped safely, the latency to brake, whether the participant crossed through the intersection safely, and whether the individual crashed. The Steinberg and colleagues (2008) article also put together a measure of risky driving by combining the measure of failing to brake and latency to brake at each intersection. The researchers were interested in the decisions made by the participants and each type of decision was given a score determining the level of risky or sensation seeking behaviour it demonstrated.

For this task, the researchers determined that there were no ties that required severing. The task itself was *interessed* as an actor in the network and identified as a measure of sensation seeking based on observed behaviour in a computerized task. The task, in itself, was determined to be *enrolled* successfully in order to measure solely behavioural sensation seeking. At this point, the researchers have *enrolled* two actors in the molecule that measure sensation seeking. The SSS was identified as a measure of sensation seeking based on the individual participant's perception of themselves. The stoplight game was identified and stabilized as an actor measuring behavioural sensation seeking. The researchers have added four *inscription devices* to the molecule. This is the last test of convincing in the article. The tests of convincing measure two behaviours over two types of measures, ensuring that the tests are woven together with no gaps. The tests support one another and convince the reader of the adolescent molecule's certainty. The text *stacks* the *inscription devices* in a way that ensures they will complement each other. The layering of multiple tests measuring the same behavioural construct provides solidity to the statement because there are now more references, playing off of each other, agreeing that the

statement is accurate. However, sometimes *dissidence* can occur, and we will see this with one of the *inscription devices* in the coming section.

### *Supporting the Hypothesis*

The results section of the text presents what can be described as the symbolic writings of the instruments (Latour & Fabbri, 2000, pg.121), of the four *inscription devices*. This is where the act of *stacking* is most present. The researchers provide visual representations of the results from the *inscription devices*. Now, in order to contend with their statement, the reader must find problems within their visual representations, as well as the writing. The researchers use a combination of tables, bar graphs, and line graphs to make the results from their inscription devices clear. All of these visual representations can be found directly in the text on pages 1770 to 1775. The first consists of a table amalgamating all of the results from all of the tests of control and tests of convincing. This provides one place in the article where the reader can see the output from all of the *inscription devices* together. The rest of the visuals consist of images representing results from specific tests. I have provided three of these in the Appendix as figures 3, 4, and 5 in order to provide more direct access to some of the visuals presented in the scientific article.

The results being presented with images can make it easy for the reader to understand the evidence presented in the text. Now, the reader does not have to just take the authors' words for granted. Instead, the reader can inspect the visual representations themselves. These visual representations provide images that correspond to the sentences in the text itself. The statement presented by the researchers gains solidity, as it becomes more and more difficult to contest. Each visual representation supports the conclusions from the researchers. They have produced a strong network of actors stabilized in the adolescent molecule and through *stacking*, the text is

able to make references within itself that complement and agree with each other to stabilise and solidify the actor-network.

The researchers add a second layer of clear *stacking* by conducting statistical analyses. Along with the visual or symbolic representation of the *inscription devices*, the researchers use tests of statistical significance to confirm the validity of their results. Now, to contend with the results of the study, the reader would have to contend with the outside research cited, the *inscription devices*, the symbolic representations, and the statistical tests of significance. Within a correspondence model of science, the model that the researchers are enacting in their role within the network, results having statistical significance is important. Statistically significant results, within this model of science, add certainty to the work for any other scientists reading the article. Thus, the statement gains solidity. All of these layers of references so far have come together to build a large network of connections. There are many actors involved, and this is the final layer that adds certainty to the statement. From the references to outside writings in the fields of neuroscience and biology, to the *inscription devices* and the visual representations of text in the form of tables and graphs, all the way to the tests of significance, there are layers of actors all in agreement with each other seeking to convince the reader. These layers play off of each other, complement each other, and agree with each other. Their identities within the molecule are stabilized and the molecule is ensured solidity.

The circle is closed. The researchers have done their best to hold together this network through their *problematization*, and to convince the reader of their concluding statement. Victory is achieved (Latour & Fabbri, 2000, pg.29). But not before an act of *dissidence* from one of the actors. While the self-report questionnaire on sensation seeking, the SSS, provided results that confirmed the hypothesis, the computerized behavioural task of sensation seeking, the stoplight

game, did not. Instead of finding that sensation seeking increases during early adolescence, peaks in mid-adolescence, then declines steadily, the behavioural task found an increase in sensation seeking at the beginning of adolescence, a peak in middle adolescence, then a steep decline thereafter (pg.1774). This pattern is similar to the hypothesized pattern, but not the same and could suggest that the hypothesis is incorrect. This actor within the network, the *inscription device* measuring sensation seeking, has detached itself from the molecule. This means that the actor was not adequately *enrolled* in the network.

When measuring impulsivity through a computerized behavioural task, TOL, the researchers severed any ties the task might have had with roles outside of its identified role in this network. They did this by measuring working memory to ensure that they could determine that the TOL task was measuring impulsivity, and only impulsivity. In addition, results were only taken from the first move of the task in order to prevent accidentally measuring planning or executive function. For the behavioural task measuring sensation seeking, the researchers did not do the same thing. At first it seemed as though the *inscription device* was thoroughly *enrolled* in the network. It was only once output from the *inscription device* was analysed that the researchers saw the actor was not stably identified in the network. The researchers provided some explanations for this *dissidence*, explanations for identities outside of this particular network that were not severed adequately. They suggest that the task could be measuring some other developing psychological function as well as sensation seeking, or that the age of 16 where individuals generally actually begin driving could impact how they responded to the task, or that the task is measuring impulsivity as well as sensation seeking (pg.1775). Whatever the reason may be, the researchers do not suggest that it means the hypothesis is incorrect. After all, the network still remains intact with many actors and overlapping references that are all in

agreement. This one actor in the network is the only *dissident*. Therefore, the researchers decide to sever ties with this actor in order to ensure certainty of the molecule. There must be something else playing into why the results were different, but it is not the uncertainty of the statement. They were unable to maintain the *enrollment* of the stoplight game actor within the network, and thus it was removed so that the molecule would only be made of strongly *enrolled* actors, and no *dissidents*.

Now that this one act of dissidence has been dealt with, victory is finally achieved. The hypothesis has been supported by numerous outside works, references, and by three *inscription devices* and their results. The researchers can now conclude that the adolescent molecule is a reality. They conclude that sensation seeking follows a curvilinear pattern with a peak in middle adolescence, and that impulse control develops linearly over time. This results in a period of heightened vulnerability to increased risk taking or sensational activities.

### *Facticity of the Statement and Neurologizing the Adolescent*

The entire text seeks to convince. It seeks to convince the reader of the statement about adolescence by using overlapping references to many actors in the network. One actor *dissented*, causing some unrest, but it was quickly evacuated from the network so as to maintain only those actors that were *enrolled* satisfactorily. All these actors play important roles in the 'discovery' of the adolescent molecule. The researchers used a laboratory to produce *inscription devices* that produced results, which gave rise to statements and visual representations, which acted to convince. All the references, instruments, results, and analyses are part of the process of translating the neurologized adolescent into a compelling fact. All the work that went in to producing the neurologized adolescent is backgrounded as if it were simply nature being observed through the tests. It was nature that was speaking, the researchers simply put it on

paper. However, from a social, relational perspective, the text's solidity, its facticity, lies in the establishing of layers of texts, instruments, visual representations, statements, and statistics. Through all of these actors in the text, there is not nature speaking, but what Latour and Fabbri (2000, pg.121) call a "literature of instruments".

The strength of the text's solidity provides for the adolescent to be defined in terms of vulnerability to risk taking, rather than in terms of requiring better parenting as was the case in the 1800s, or in terms of dangerousness as was the case in the 1900s. At the end of the scientific article, we have learned one main thing about adolescence. We have not learned a definite start point or end point of adolescence or how adolescents should be treated. We have learned that adolescence is a period of heightened vulnerability to risk taking and we have learned that the underlying explanation for this is the limbic, sensational brain system developing against the cortical, impulse control brain system. To be an adolescent is to be an individual more likely to take risks. The adolescent is becoming neurologized, becoming defined more and more by neuroscience. The phenomenal behaviour of adolescence is becoming understood in terms of neuroscience, brain and mind development, and vulnerability to certain types of activities. It is ushering in a new era, where neuroscience can help to explain and understand psychological and cognitive behaviour. However, adolescence is not fully enveloped by this type of explanation yet. In science, as soon as credit is obtained, as soon as victory is achieved, it is assigned limitations.

When working from a correspondence model of science, researchers are careful not to overstate their findings. They do not want to open themselves up to easy criticisms or contestation. When concluding their findings, the researchers use *hedges* such as "…appears to be…", and "…would be expected…" (Steinberg et al., 2008, pg.1776). They carefully conclude

that their results suggest the adolescent's behaviour can be explained in this way, but they do not exaggerate their certainty. It is up to others now, to confirm the solidity or certainty of the text by citing it and referencing it, by *black boxing* it. Therefore, the adolescent is neurologized through the production of this text's statement, but the neurologization is still limited at this point. This neurologized adolescent can easily travel. It can be copied, borrowed, referred to, and solidified. This type of translation is what happened in the legal realm, when it was referred to and solidified in two United States Supreme Court cases, which I discuss in part three. There, the neurologization of the adolescent becomes more certain, more ingrained in society's perception of reality, of adolescence.

Before moving on to the translation of this proposition from the laboratory to the legal realm, I would like to take a step back and look at one particular decision made in the research process and how this decision impacted the concluding statement about adolescence. In the next part of the analysis, I will describe the decision by the researchers to separate sensation seeking and impulsivity into two different behavioural phenomena, controlled by two different brain systems, rather than as one behavioural phenomenon controlled by one brain system. This will be a description of Callon's (2003) first type of translation, that of translating something from the macrocosm of the world to the microcosm of the laboratory. This is a description of how the adolescent, specifically adolescent brain development, was brought into the laboratory to become an important actor in the molecule.

## 1.10. Upstream Analysis Two: One Piece of the Molecule – The Separation

In this part of the analysis, I delve into one set of actors that went in to producing the scientific statement in the Steinberg and colleagues (2008) scientific article. I describe Callon's first type of translation, that is, translating an entity from the outside world into the microcosm of the laboratory (Callon, 2003, pg.59). I follow the science further upstream in order to understand the researchers' decision to separate sensation seeking and impulsivity as two distinct behaviours, as two distinct actors. This is a description of how the adolescent was translated from the outside world into the laboratory. Outside the laboratory, the adolescent can be defined by many different things, but inside the laboratory, the adolescent is defined by two behavioural characteristics, impulsivity and sensation seeking. The researchers bring adolescence into the laboratory through these two actors. This impacts how adolescence is measured and defined in their research and in the published scientific text.

This is a look at just one of the decisions made by the researchers and how it impacts the research. There were many decisions made, and many actors involved that I could have studied as well. This specific decision was chosen because there is some controversy in the fields of neuroscience and psychology as to whether or not sensation seeking and impulsivity are actually separate, or if they are one and the same. Therefore, in order to ensure that their statement about adolescence maintains solidity and is taken as true, the researchers must sever any ties that the actors have with other definitions or explanations of them. The way in which the researchers *interesse* and *enroll* the actors of sensation seeking and impulsivity secures their identities within the project and severs their identities with other roles outside of this adolescent molecule.

In addition to maintaining solidity, this decision brings the adolescent closer to a neuroscientific definition and explanation. The adolescent becomes defined through the brain and its development because of this decision by the researchers, thus explaining the behavioural phenomena observed in adolescence through neuroscience terms. Through this description, it should become clear that the adolescent becomes more neurologized – defined and explained by neuroscience.

In order to demonstrate the facticity gained and the neurologization of adolescence, I first begin with a description of how sensation seeking, and impulsivity are defined. This involves how the actors are defined in the Steinberg and colleagues (2008) scientific text, how other researchers define the actors, and the lack of consensus on how they should be defined. I then discuss the decision made in the Steinberg and colleagues (2008) paper to define the actors as separate from each other. I discuss how this decision allows them to build the network in connection with neuroscience and knowledge from brain imaging scans. This demonstrates how the adolescent becomes neurologized from this decision. Finally, I discuss how the separation of these actors provides the researchers' statement with solidity. This decision provides the researchers with a definition of adolescence that coincides with knowledge from the legal world, allowing it to be easily translated outside the laboratory.

### 1.10.1. The Jingle Jangle of Sensation Seeking and Impulsivity

Choosing how to define actors within a network can have a large impact on the research. It can impact the actors' *interessement* and *enrollment*. It can also impact the results taken from the *inscription devices*. I study this piece of the research process because the decision to define sensation seeking and impulsivity as separate actors in the Steinberg and colleagues (2008) text

played a large role in building and strengthening the neurologized adolescent molecule. At this stage, before the research has begun, different actors need to be *interessed* into the network. Part of this involves *problematizing* the actors that they want to measure in a way that stabilizes their identity within the project. In this sense, the researchers must translate the adolescent from the macrocosm of the outside world, into the microcosm of the laboratory. In order to bring the adolescent into the laboratory in a way that can be measured by the *inscription devices*, a particular definition of the adolescent is required. The researchers *enrolled* the adolescent by *problematizing* it in a way that it becomes identified and defined in the network through the actors of impulsivity and sensation seeking. Therefore, the researchers were required to define sensation seeking and impulsivity as actors within the network. How they decided to *problematize* these actors in the project impacted how the adolescent was defined and how the adolescent was thus translated into the science laboratory.

The researchers had to carefully define each actor in the network. Since they are described as behavioural characteristics, choosing specific behavioural attributes would allow the actors to be measured. Steinberg and colleagues (2008), therefore, defined impulsivity as a "…lack of self-control or deficiencies in response inhibition; it leads to hasty, unplanned behavior" (pg.1765). On the other hand, sensation seeking was defined as a "…tendency to seek out novel, varied, and highly stimulating experiences, and the willingness to take risks in order to attain them" (Steinberg et al., 2008, pg.1765). Defining the actors in this way means that each can be measured separately. There are behavioural attributes that would be impulsive without leading to rewards. It is also possible to partake in sensation seeking activities without being impulsive. So, according to the Steinberg and colleagues (2008) article, sensation seeking and impulsivity are two separate actors, controlled by separate brain regions. Sensation seeking is

described as being a part of the limbic system, responsible for reward and emotion response, while impulse control is related to the cortical system, responsible for cognitive decision making (Steinberg et al., 2008). This decision to *problematize* these actors as separate, to *enroll* them as two distinct actors in the molecule, impacts the research conducted and the conclusions drawn. There are many other researchers who might define impulsivity and sensation seeking differently, and Steinberg and colleagues (2008) could have chosen to follow them.

Some researchers define sensation seeking and impulsivity as separate entities (Casey et al., 2008; Dahl, 2004; Drevets & Raichle, 1998; Galvan et al., 2006; 2007; Steinberg, 2004; 2007; 2008), just as Steinberg and colleagues (2008) did. Many researchers, however, have defined sensation seeking differently than Steinberg and colleagues (2008). There are those that define sensation seeking and impulsivity as traits of the same overall behaviour characteristic, such as being traits within the personality of extraversion (Dickman, 1990; Durston et al., 2006; Ernst et al., 2005; Eysenck & Eysenck, 1977; 1978; Waller et al., 1991), those that define impulsivity as a trait within the behaviour of sensation seeking (Cloninger et al., 1991; Farley & Farley, 1967; Patton et al., 1995; Zuckerman et al., 1978), and those that define sensation seeking as a trait within the behaviour of impulsivity (Chambers et al., 2003; Depue & Collins, 1999). Therefore, Steinberg and colleagues (2008) were forced to sever ties with all of these different definitions in order to *enroll* the two actors into their adolescent molecule – the adolescent actor-network. The researchers had many options and could have alternatively decided to use one of these definitions of the actors. Instead, they decided the actors were separate behavioural characteristics.

All of these different ways to define these two actors stem from the jingle jangle fallacies. The jingle fallacy refers to two constructs which are defined as equivalent, or being the same

thing, while in reality they are very separate (Whiteside & Lynam, 2001, pg.670). This means that two constructs, such as sensation seeking and impulsivity, are separate entities just as Steinberg and colleagues (2008) propose, but they are treated as if they are one and the same just as Zuckerman and colleagues (1978) or Patton and colleagues (1995) do. On the other hand, the jangle fallacy refers to two entities being defined as separate, but they are, in reality, equivalent or the same thing (Whiteside & Lynam, 2001, pg.670). According to the jangle fallacy, Zuckerman and colleagues (1978) and Patton and colleagues (1995) would be correct in proposing that sensation seeking and impulsivity are equivalent, while Steinberg and colleagues (2008) would be erroneously labelling them as separate. The question to ask here is which one is correct? This is where the controversy around the decision lies.

Most entities might only suffer from either the jingle or jangle fallacies, but sensation seeking and impulsivity suffer from both the jingle and jangle fallacies. Some researchers argue that there is a single decision making system that determines both sensation seeking and impulsivity, while others argue that there is an interaction between two decision making systems that causes sensation seeking and impulsivity separately (McClure et al., 2004). Suffering from both the jingle and jangle fallacies, Whiteside and Lynam (2001, pg.670) suggest that the advancement of knowledge on the entities is inhibited. Choosing to define the entities in the incorrect manner could prevent development of correct knowledge or promote development of knowledge that may be incorrect. Therefore, the decision of whether or not the two constructs are different from each other or equivalent to each other is important. Using these particular actors means making an important decision that will impact the strength of the actor-network. Make one choice and the actors may not be *enrolled*. The research may face acts of *dissidence*. Make a different choice and the research may gain strong allies. The decision is surrounded with

controversy and it is up to the researchers to choose how the actors are *problematized* within the molecule.

Steinberg and colleagues (2008) want their network of connections to be strong, interconnected, and difficult to dispute. They brought in many allies and actors at different times to support the network and this particular decision does the same thing. The decision to separate the two actors – sensation seeking and impulsivity – provides the researchers with the ability to bring in friends from neuroscience, strengthening its solidity and further neurologizing the adolescent. It also leads to results from the *inscription devices* that point to a particular conclusion drawn by the researchers. This conclusion, or statement, corresponds with research on adolescent behaviour outside of the laboratory, particularly in law, again increasing the solidity of the proposition from the Steinberg and colleagues (2008) scientific article.

### 1.10.2. Mobilization of Neuroscience Allies

The Steinberg and colleagues (2008) text had to translate the adolescent entity into the science laboratory. The researchers decided the adolescent would be translated into the laboratory through the actors of sensation seeking and impulsivity. Then, to *interesse* these actors, they had to *problematize* them in a way that stabilized their identity within the project and severed any ties they had with outside roles. The researchers decided to define their identity within the project as two separate actors, two separate behavioural characteristics that together, would define adolescent behaviour. This had two major impacts on the research. First, this meant that the actors of sensation seeking and impulsivity could be linked with research in the field of neuroscience, thus growing and strengthening the actor-network molecule. The second, discussed in the following section, is that the actors were severed from their identity as a single

actor in other research, thus providing the project with a different definition of adolescence than other projects, one that could form a connection with the legal realm.

How did this particular decision strengthen the connection of the network to neuroscience? The Steinberg and colleagues (2008) article was able to build a connection between the definitions of sensation seeking and impulsivity, and the limbic and cortical brain regions studied in neuroscience. Casey and colleagues (2008) explain that, on a cognitive behavioural level, adolescents are often defined as impulsive and as risk takers where the two characteristics are defined synonymously, without any appreciation for their distinct developmental trajectories. In many studies, these two constructs are defined as one and the same thing, however, there are those that do not (Casey et al., 2005; Galvan et al., 2007; Steinberg, 2007; Tamm et al., 2002). Defining them separately allows a connection to form between these actors and the developmental trajectory of different actors, two systems in the brain. These two systems comprise many brain regions. The first brain system actor, the limbic system, which is said to be connected to emotional response, and thus to sensation seeking, comprises the amygdala, ventral striatum, medial prefrontal cortex, orbitofrontal cortex, and superior temporal sulcus (Steinberg et al., 2008, pg.1764). The second brain system actor, the cortical system, responsible for cognitive decision making, and therefore connected to impulse control, consists of the lateral prefrontal and parietal cortices, and the connecting parts of the anterior cingulate cortex (Steinberg et al., 2008, pg.1764). Each of the two brain systems consists of multiple sections of the brain, but each brain system develops along different timelines. Therefore, if the behaviours of sensation seeking and impulsivity are linked to each brain system, these actors too, develop along different timelines.

Based on neurobiological evidence presented and *stacked* by Steinberg and colleagues (2008) in their text, the limbic, or emotional system, develops over time, in the shape of an inverted-U. Therefore, the emotion response system, or sensation seeking, increases dramatically in early to mid adolescence, then declines from there to the end of adolescence. This is a pattern of brain development that has been studied through fMRIs and the researchers present these studies as allies to their project. Then, they produce their own tests, self-report and behavioural, to measure sensation seeking. The *inscription devices* produce results which were then presented visually as symbolic representations of the instruments in the published paper. The researchers found the same inverted-U shape development for sensation seeking that has been found for the limbic, or emotion response, brain system. This means a connection between their research – sensation seeking – and previous research in the field of neuroscience – the limbic system – is built. The text is able to mobilize the actors of fMRIs and the limbic brain system to produce the neurologized adolescent molecule.

The same thing is then done with impulsivity. Based on the allies that Steinberg and colleagues (2008) present, the cortical, or cognitive decision-making system, develops linearly throughout adolescence. Therefore, the cognitive decision-making system, or impulse control, increases slowly and steadily throughout adolescence and into adulthood. This pattern of brain development has also been studied through fMRIs and these studies are presented as allies to the current research. Then, again, the researchers produce their own self-report and behavioural tests, this time to measure impulsivity. These *inscription devices* produce results which are presented visually in the published paper. The researchers have found that the same linear pattern of development in the cortical, or cognitive decision making, system is also true for impulse control. They are able to further the connection between their research – impulse control – and

previous research – the cortical system – in the field of neuroscience. More allies are mobilized, and the adolescent molecule is now stably connected to actors from the field of neuroscience.

The adolescent is thus translated from the outside world into the science laboratory through the actors of sensation seeking and impulsivity. The pattern of development of sensation seeking produced from the *inscription devices* is similar to the pattern of development of the limbic brain system presented in the references within the text. Because the patterns match, a connection can be drawn between the actor of sensation seeking and the actor of the limbic brain system within the network. Sensation seeking behaviour in adolescence is linked to the development of the limbic brain system, therefore providing the adolescent entity's behaviour with an explanation rooted in neuroscience. Likewise, the resulting pattern of impulsivity from the *inscription devices* is similar to the pattern of development in the cortical brain system presented in the references. Because the patterns are matching, a connection is drawn between the actor of impulsivity and the actor of the cortical brain system within this network. Lack of impulse control in adolescence is provided with a neuroscientific explanation. Therefore, by bringing the adolescent into the network through the two actors of sensation seeking and impulsivity, this connection to neuroscience allies can be made.

The development of these definitions and connections provides solidity to the research being conducted. Not only are the researchers building strong connections with previous research or previous research in related fields, they are building strong connections between their actors and allies in the field of neuroscience as well. This is especially convincing to the reader when social sciences and society are experiencing a neuro-turn. This neuro-turn in society was discussed previously but is again important to consider here. Science, in general, has a lot of cultural authority over facts and truths. However, during this neuro-turn, neuroscience in

particular, carries a lot of weight. The researchers are able to build strong connections between the actors in this network and other allies in the scientific community. Thus, the decision to define impulsivity and sensation seeking in this particular way solidified the facticity of the research. The development of sensation seeking and impulsivity in adolescence is now connected with fMRI evidence for the development of the limbic and cortical brain systems. In order to contest this research, and the statement about adolescence put forth in the text, the reader would have to also contend with fMRI studies from the field of neuroscience. The adolescent was translated into the laboratory while allies from neuroscience were being *enrolled* in the molecule. This decision provides solidity to the statement produced by the science laboratory.

By defining sensation seeking and impulsivity in this way, the researchers have built connections to neuroscience, thus lending solidity to the statement. This decision also further defines adolescent behaviour in terms of neuroscience, and neurologizes the adolescent molecule. The adolescent outside the laboratory is defined by many things, but once it is in the laboratory, it becomes *problematized* as comprising sensation seeking and impulsivity. All other ties the adolescent has outside the laboratory are severed. Sensation seeking and impulsivity are identified, in the research, as actors who are connected with the limbic and cortical brain systems. Therefore, the adolescent becomes defined by the limbic and cortical brain systems. Inside the laboratory, the adolescent is identified, defined, and explained through neuroscience, thus neurologizing the adolescent. This connection to neuroscience is not the only way the statement gains solidity and the adolescent becomes neurologized through the decision to separate the actors of sensation seeking and impulsivity. This is also established through the definitions' connections to the world outside of the scientific realm.

### 1.10.3. Mobilization of Legal Allies

The decision to separate sensation seeking and impulsivity helped the research gain allies in neuroscience who could solidify the statement while also neurologizing the adolescent. However, this decision also connects the adolescent actor-network molecule to allies outside the domain of science as well. This connection outside the laboratory also further neurologizes the adolescent. By separating the actors, the research concludes that the period of life with the highest vulnerability to risk taking is in middle adolescence. This is due to the curvilinear, inverted-U pattern of sensation seeking development, combined with the more slowly and linearly developing impulse control, the dual systems model. This is connected to the development of the limbic and cortical brain systems, each corresponding to emotional response and cognitive decision making, respectively. A question then arises as to how the research might have concluded something different if the two actors, sensation seeking and impulsivity, were conflated instead of separated.

Some have suggested that conflating the two actors, and focusing on the pattern of development of impulsivity, would mean that children would have the highest vulnerability to risk taking, and this vulnerability would decrease into adolescence, and further into adulthood (Casey et al., 2008; Galvan et al., 2007). Instead of having two different developmental trajectories, one with an inverted-U pattern and the other with a linearly increasing pattern, there would be one developmental trajectory where impulsivity decreases linearly from birth. In this case, the period of vulnerability to risk taking would begin at birth and would decrease steadily over time (see Figure 6 in Appendix). Now, it is important to ask, why does this matter? Why is this important? What difference does this make? First, adolescence would not be neurologized. Adolescence would not be defined in terms of neuroscience. This would be because the research

presented by Steinberg and colleagues (2008) would not maintain as much solidity within the field of neuroscience. Their findings would not correlate with that of neuroscience, thus adolescence would be defined in terms of psychology or social phenomena or some other explanation. The neurologization of adolescence would no longer be occurring. There is a second reason why this difference matters, and it relates to the world outside the laboratory. It exists in the legal and criminal justice domain.

For years and years, the fields of criminology and law have collected statistics on crime as it relates to age. From these statistics, the age-crime curve was developed. While this crime curve varies slightly from crime to crime (Steffensmeier, Allan, Harer, & Streifel, 1989, pg.806), the general pattern has held true for years. The age-crime curve states that offending increases in late childhood, peaks in middle adolescence, then decreases into adulthood (Loeber, 2012, pg.11). If sensation seeking and impulsivity are conflated, then the pattern of vulnerability to risk taking means that most crime would occur in childhood. This, however, does not match the official crime statistics. On the other hand, as the Steinberg and colleagues (2008) text separates the actors of impulsivity and sensation seeking, the pattern of vulnerability to risk taking means that crime would peak in middle adolescence. This statement coincides with the official crime statistics collected over years. Now, through this decision, the researchers are able, not only to bring in allies from neuroscience, but also to bring in allies from law to help solidify the statement. Not only is the adolescent neurologized through the separation of these actors, but the neurologized adolescent can be solidified in the legal domain in addition to being solidified in the scientific domain. The allies of law, criminology, and more specifically, the age-crime curve, have been mobilized to strengthen the certainty of the statement and grow the actor-network of the neurologized adolescent molecule.

The acceptance of Steinberg and colleagues' (2008) statement can be taken one step further. It not only coincides with the age-crime curve statistics, but it is also perceived, in law, as common sense knowledge, thus making the statement simply a scientific confirmation of what is already known about adolescence. The *Miller v. Alabama* (2012) oral arguments contend that this science confirms "…what we know about kids" (pg.23). Additionally, the court opinions stated that the "…decisions rested not only on common sense – on what any parent knows – but on science and social science as well" (Fallon, 2012, pg. 471). By separating sensation seeking and impulsivity as different entities, the researchers were able to produce a proposition that confirmed the age-crime curve and that confirmed what law, and any parent, knows about youth. The proposition builds many allies into its network and this now includes the law, specifically crime statistics and the United States Supreme Court. The adolescent is neurologized through the decision to separate the two actors, and this neurologization of the adolescent is confirmed as fact in the world outside the science laboratory.

We have observed the statement building allies, solidifying certainty, and neurologizing the adolescent upstream by studying the scientific process of fact production. With Callon's second type of translation, we saw how the proposition used allies, *inscription devices*, actors, and *stacking* to build the statement and ensure its solidity, and how this solidity contributed to the neurologization of adolescence. In this section, we have seen how the decision to separate sensation seeking and impulsivity constitutes Callon's first type of translation, translating from the outside world into the laboratory. The adolescent was translated into the laboratory before any of the other allies could be brought in. This decision to separate the actors provided the opportunity to bring in neuroscience studies, and specifically fMRI technology, as an ally. This solidified the certainty of the final statement, and neurologized the adolescent. Without this

decision, the phenomena of adolescent behaviour would not have been defined in terms of neuroscience, and the adolescent would not be neurologized. The decision to separate the actors also provided the opportunity for the statement to be confirmed as fact by the age-crime curve and the United States Supreme Court. This meant that the statement gained more solidity, this time outside the scientific sphere, and the adolescent became more neurologized. Without the separation of sensation seeking and impulsivity, the neurologized adolescent might not have gone beyond the laboratory, and the statement might not have gained solidity outside of the laboratory either.

This connection to law is important as I move downstream of the research – away from its production – to describe the process through which the adolescent was translated from the science laboratory and into the legal sphere. This is Callon's third and final type of translation. Again, I will describe how the statement gains solidity and the adolescent becomes further neurologized, this time outside the science laboratory and after the statement has actually been published in a scientific journal.

## 1.11. Downstream Analysis: Solidifying the Adolescent Molecule in Law

In this final part of the analysis, I focus on the translation of Steinberg and colleagues' (2008) text to the outside world, specifically law. This depicts Callon's (2003, pg.59) third type of translation, a translation from the scientific laboratory to the outside world. In this case, the statement concluded from the Steinberg and colleagues (2008) text is translated from their laboratory to supporting documents submitted by the American Psychological Association

(APA) and the American Medical Association (AMA), and is then translated from these supporting documents to the court opinions in deciding upon sentencing principles for youth.

This description clearly demonstrates how the use of Steinberg and colleagues' (2008) scientific article in law solidifies the work. I describe how law, as an institution that produces truths, can solidify the facticity of the statement produced from the scientific laboratory. As the statement produced from the Steinberg and colleagues (2008) laboratory gains solidity, the adolescent becomes more neurologized. The adolescent is now partly defined in law through neuroscience terms and evidence. Law, which decides how to treat adolescents in the criminal justice system, has based their sentencing decision on evidence from neuroscience, thus establishing that adolescent behaviour should be understood in terms of neuroscience. The neurologized adolescent is translated beyond the laboratory.

I first describe the court cases that made use of Steinberg and colleagues' (2008) statement about adolescence. I describe how this science was used in the case and how this science impacted the conclusion made by the court. I then describe the first step of this translation, how the statement concluded in the article was translated from the laboratory to the supporting documents submitted by the APA and AMA. Then, I describe the second step of the translation where the statement moves from the supporting documents to the court opinions and the conclusions drawn by the court. These descriptions will highlight how each step of the translation increases the solidity of the statement from the Steinberg and colleagues (2008) text, and how each step of the translation increases the neurologization of the adolescent, thus further growing and strengthening the actor-network molecule.

### 1.11.1. Science in the Supreme Court Cases

The *Roper v. Simmons* (2005) case, discussed in chapter one, signalled the beginning of the turn back from harsh punishments to more middle ground treatment of youth. It abolished the death penalty for youth, based on evolving knowledge of adolescence as a distinct period of human development involving risky behaviour (Coopman, Vertesi, Lynch, & Woolgar, 2014, pg.291). The case brought up the question of whether capital punishment was a violation of youths' protections against cruel and unusual punishment under the eighth amendment. The goal of the appellants was to have a bright line drawn where anyone under 18 could not be sentenced to capital punishment (Coopman et al., 2014, pg.291; *Roper v.* Simmons, 2005, pg.25). This was the decision concluded by the court.

There was a lot of evidence presented in the *Roper v. Simmons* (2005) case, among it, new knowledge from the field of neuroscience on the immaturity of adolescents (Coopman et al., 2014, pg.291). However, statements in the oral arguments such as "we know this from common sense and it's been validated by science" (*Roper v. Simmons,* 2005, pg.38) demonstrate that the science is being used as a justification for pre-existing ideas of adolescence and for making judicial decisions with important consequences. A second clear example of this in the oral arguments for the case is seen when Justice Breyer says, "I thought that the – scientific evidence simply corroborated something that every parent already knows…" (*Roper v. Simmons*, 2005, pg.40). The science in this Supreme Court case acted as a reinforcement of already assumed knowledge about adolescents. Just as some scientific evidence was used in the 19th century, some neuroscientific evidence was used in the *Roper v. Simmons* (2005) case. With this evidence in hand, the law reinforces our way of thinking about adolescence.

Coopman et al. (2014, pg.295) defined the pattern of science as justification of a 'neurorealism'. In the 1980s, youth who were committing violent crimes were deemed dangerous and requiring adult sentences, however as the cycle of juvenile justice progressed towards more middle ground treatment of youth, scientific evidence became helpful as it complemented current societal and cultural beliefs about adolescence, development, and youth crime. Scientific work is used in these cases because it reinforces current assumptions and understandings of adolescence. The law is able to use this science as a voice of authority in reinforcing these assumptions.

Science as a complement and confirmation of legal reform is also present in the *Graham v. Florida* (2009) and *Miller v. Alabama* (2012) Supreme Court cases. In these Supreme Court cases we witness an emergence of science – particularly biological science – as a key factor influencing juvenile justice sentencing decisions. Just as there is the 'social' cycle of juvenile justice whereby policies become more harsh, then more lenient, then more harsh again based on perception of the amount of crime (Bernard & Kurlychek, 2010), we can see a 'scientific' cycle of juvenile justice forming as well. The 19$^{th}$ century introduced psychological and biological theories of juvenile delinquency which then faded from popularity (Bernard & Kurlychek, 2010; Mays & Winfree, 2006; Shoemaker & Wolfe, 2016). Today, again, we see the use of scientific theories to justify sentencing principles. Currently, the scientific understanding of adolescence, proposed in the Steinberg and colleagues (2008) text has strong connections to actors within the legal realm. Time, and more close watching of this network of connections, will tell if this scientific cycle will continue as before, with the statement fading from popularity in law, or if it will continue to maintain strong connections and continue growing the actor-network.

Neurorealism is not only useful for reinforcing legal decisions. It is also useful in validating and solidifying scientific statements. According to Aronson and Cole (2009), science

acts as an authority in society and public discourse. They also assert that law is a truth-producing institution as well, however, it does not carry the same amount of authority in society as science. So, law relies on scientific developments to make decisions that are based on knowledge, facts, and evidence. Science also benefits from this use. Society relies on law to determine the truth about important situations or phenomena. Therefore, if there were two contradictory statements about adolescents from two different scientific articles, and one was used to determine the criminal sentencing of youth, that one would be determined true by law, and by extension society, while the other would be ignored or determined to be wrong. Being referred to by law is beneficial for a scientific statement's solidity as an actor-network. This will be demonstrated through the cases of *Graham v. Florida* (2009) and *Miller v. Alabama* (2012). First, I provide an overview of the two cases and the decisions made in the cases.

The *Graham v. Florida* (2009) case was an eighth amendment dispute whereby the appellants were arguing that life without the possibility of parole constituted cruel and unusual punishment for youth because of their special status as separate from adults. The court decided to abolish life without parole as a possible sentence for youth under 18 who had committed a crime other than homicide (Wagner, 2010). The court relied on oral arguments, as well as many supporting documents to make their final decision on the matter. Among the supporting documents were two *amicus briefs*; one from the APA and one from the AMA. These briefs referenced much of the emerging scientific work on adolescence, including the Steinberg and colleagues (2008) article depicting adolescence as a period of impulsivity and sensation seeking behaviour (AMA, 2009; APA, 2009). These briefs were specifically cited in the court opinions from the case as a part of the basis for the decision made (Wagner, 2010). Here we see a continuation of science as a justification for youth sentencing decisions.

The *Graham v. Florida* (2009) court opinions relied, for the most part, on two points of interest: the precedence set by the *Roper v. Simmons* (2005) case and the scientific evidence presented by the *amicus briefs*. Based on these two points, youth were defined as having a lack of maturity, having an underdeveloped sense of responsibility, being more vulnerable to influences, and being in the process of development (Wagner, 2010, pg.68). I will further analyse how the statement about adolescent behaviour from the Steinberg and colleagues (2008) scientific text was translated from the science laboratory, to the outside world, to the *amicus briefs*, and to the final comments and statement made by the United States Supreme Court in their opinions, providing the statement with solidity and further neurologizing the adolescent actor-network molecule.

Along with the *Graham v. Florida* (2009) case is a more recent Supreme Court case, that of *Miller v. Alabama* (2012). This was also an eighth amendment dispute regarding life without parole as cruel and unusual punishment. This time the defendants were specifically looking for the Supreme Court to abolish life without parole for all youth under 18, including those who had committed homicide. The court decided that mandatory life without parole as a sentence for youth under 18 who committed homicide was unconstitutional (Fallon, 2012). There are states where the mandatory minimum for adults who commit certain crimes is life without parole and the maximum is capital punishment. Therefore, because youth cannot be sentenced to capital punishment, if they are transferred to adult court in those states, there must be another sentencing option provided to the judge to hand down to the youth. Again, as with *Graham v. Florida* (2009), the court relied on oral arguments and supporting documentation, including briefs from the AMA and APA (Fallon, 2012). The briefs again referenced the work by Steinberg and colleagues (2008) defining adolescents as impulsive sensation seekers (AMA, 2012; APA,

2012), and these briefs were cited in the court opinions as part of the basis of the conclusion drawn (Fallon, 2012). The use of science in United States Supreme Court cases continues in this case, carrying through the same statements about youth as the previous cases. The information presented was still confirmatory of the court's general beliefs about youth.

The *Miller v. Alabama* (2012) case again relied on precedence, but this time on the precedence from both *Roper v. Simmons* (2005), and *Graham v. Florida* (2009). The court reiterated the same opinions of adolescence as in the previous case where youth are considered to have a lack of maturity, have an underdeveloped sense of responsibility, be impulsive and take risks, be vulnerable to influences, and to have a character that is not yet fully formed like that of an adult (Fallon, 2012, pg.461). Together with the *Graham v. Florida* (2009) case, I will analyse the translation of Steinberg and colleagues' (2008) statement about adolescence as a time of impulsivity and sensation seeking from the laboratory, to the *amicus briefs* submitted by the AMA and APA, and to the court opinions provided by the Supreme Court, demonstrating how the adolescent actor-network molecule gains solidity through this translation and how the molecule becomes further neurologized.

### 1.11.2. Displacing the Adolescent from the Laboratory to the Wider Scientific Community

Steinberg and colleagues' (2008) scientific article takes part in Callon's third translation in two steps. The first step is when the published research paper is referenced in the supporting documents for the Supreme Court cases, namely the *amicus briefs* submitted by the AMA and APA. Here, the scientific text is displaced outside of the science laboratory and into the wider scientific community. The second step in the translation is when those supporting documents are referenced by the court in making their final decisions on each case. This step displaces the text

even further from the science laboratory to the criminal justice sphere. Each of these steps provide the research the opportunity to gain solidity, which it does, and by gaining this solidity, the period of development known as adolescence becomes more neurologized. I explore this here, beginning with the first step of the translation.

The APA is a scientific and professional organization with one of their goals being to increase and disseminate knowledge about human behaviour (APA, 2009, pg.1). The association acts as an authority on psychology and provided the *amicus briefs* to the court in both cases to provide what they believed was relevant knowledge about adolescent behaviour (APA, 2009; 2012). Likewise, the AMA is a professional organization of physicians and medical students that aims to promote science and medicine (AMA, 2009, pg.1). The AMA *amicus briefs* submitted in both cases also provided relevant scientific findings from medicine, psychiatry, and psychology (AMA, 2009; 2012). Both groups consist of hundreds of thousands of authorities in their respective scientific fields and therefore, to be referenced in the *amicus briefs* is to be referenced and supported by that large authority in the scientific community. Being referenced through a positive *modality* by these groups means there is certainty to the statement or research, and being referenced through a negative *modality* might mean there is serious uncertainty with the research.

The way that the Steinberg and colleagues (2008) paper is referenced by both groups in both Supreme Court cases is through positive *modalities* only. There are no *hedges* on the sentences that point to questioning the research such as 'sometimes', 'it is possible', or 'it may be the case'. The briefs instead use confirmatory language – *boosters* – stating the information as a matter of fact. Some examples of this include "…adolescents exhibit a disproportionate amount of reckless behaviour…" (AMA, 2009, pg.5), and "…adolescents are less capable of self-regulation than adults…" (APA, 2012, pg.8). There is no questioning of the research that was

conducted. The briefs are certain about the information they are providing on adolescence and the information they are providing comes directly from the Steinberg and colleagues (2008) article. The statements from the paper gain solidity as they are referenced as a certainty by the authority of both groups.

Another way we can tell that the research is being referenced by positive modalities is because the briefs point away from the production of the research rather than towards it. In the case of *Graham v. Florida* (2009), the AMA stated that "Numerous studies of adolescent behaviour over the last two decades confirm the stereotype that adolescents…" (2009, pg.5). They are pulling away from the production of the research and grouping multiple studies together. The findings of the Steinberg and colleagues (2008) paper match the findings of other research, therefore the production of the findings is unimportant. It is only important that the information is known to be true because it has been confirmed by a lot of scientific research. Therefore, they know this information to be accurate. This knowledge is becoming *black boxed*, certainty and solidity is added each time the paper is referenced in this manner – downstream and away from its production.

A second example of this can be seen in the APA *amicus brief* for the *Miller v. Alabama* (2012) case. They stated that "Researchers examined differences in impulsivity between ages 10 and 30, using both self-report and performance measures, and concluded that…" (2012; pg.11). While this does reference the specific types of measures used to study the period of adolescence and the ages of the participants, it does not call the methods into question. By referring to the age of the participants and the measures used, the brief highlights the depth of the research. This includes the vast range of participants studied, as well as the multiple *inscription devices* used. The reader of the brief can confidently move on knowing that the research relied on by the brief

is all encompassing and not in need of further questioning. Therefore, by referring to the specific methods used, the briefs are still using positive *modalities* and pulling attention away from the methods of production. This positive, downstream *modalization* of the Steinberg and colleagues (2008) scientific article makes it more of a certainty, a fact, a part of the confirmed knowledge about adolescence. The neurologized adolescent actor-network molecule produced by Steinberg and colleagues (2008) has been translated outside the laboratory and, through this translation, has gained solidity.

One important note on the referencing of the paper in the *amicus briefs* is how the research referenced is treated and how much of the briefs are actually specifically discussing the research conducted by Steinberg and colleagues (2008). In each of the cases, both the AMA and APA list their references as a table of authorities. Therefore, the AMA and APA groups are immediately assigning authority to the authors cited in the briefs. In the *Graham v. Florida* (2009) case, the APA references the scientific article on two of the 34 pages and the AMA references the research on three of the 32 pages. In addition to this, the APA references a total of 56 authorities, nine of which involve Steinberg as a first author. One of those is the Steinberg and colleagues (2008) text on which I am interested. The AMA references a total of 87 authorities, five of which involve Steinberg as a first author. One of those is again, the specific scientific article being analysed. Similarly, the APA in the *Miller v. Alabama* (2012) case references the research on two of 36 pages and the AMA references the research on three of the 37 pages. The APA references a total of 65 authorities, 10 of which involve Steinberg as a first author. One of those is the particular scientific text I am analysing. The AMA references a total of 99 authorities, five of which are first authored by Steinberg. Again, one of those is the text we are discussing.

Why am I mentioning this? It is all to say that the Steinberg and colleagues (2008) scientific article does not play a large role in the knowledge being disseminated by these groups to the court. However, Latour and Fabbri (2000) discuss how articles are, by definition, replaceable. You must be able to build on the article. Therefore, "if this article is true, another article may refer to it in a half sentence; if it is false, other articles may challenge it or it may be totally ignored" (2000, pg.121). The best possible outcome for the Steinberg and colleagues (2008) text to gain solidity is to be mentioned, paraphrased, or cited at all in the *amicus briefs*. The positive *modalizations*, no matter how small or seemingly inconsequential, confirm its certainty and truthfulness and provide it with more solidity as a statement. In addition, the APA and AMA are made up of numerous authorities across many scientific fields. So, a reference to the molecule from these groups signifies a major scientific consensus of the actor-network molecule's solidity.

A second note on the strength of the facticity of the Steinberg and colleagues (2008) scientific text comes in the form of comparing the *amicus briefs* with each other. The *Miller v. Alabama* (2012) case came three years after that of *Graham v. Florida* (2009), however both the AMA and APA briefs repeated the same information about adolescents (AMA, 2009; 2012; APA, 2009; 2012). Almost word for word, the AMA brief in 2009 and in 2012 state the same information and indicate that the same knowledge holds true. The same statements are made, the same references to the Steinberg and colleagues (2008) text are made, and the same general definition of adolescence is provided. In a field where new developments are emerging everyday, these statements remain constant three years later, emphasizing their stability in the knowledge base and further black boxing them. In this way, the actor-network – the neurologized adolescent molecule – proves to be extremely strong and stable. The research gained solidity in 2009, and

again in 2012, in the same context, through the same authorities. These scientific allies, bridging the gap between the science and legal realms, are mobilized to provide the molecule with solidity, and to grow the network longer and stronger.

I also note how, as the research by Steinberg and colleagues (2008) gains solidity in this step of the translation, the adolescent also becomes more neurologized. I reiterate here the main statement about adolescence from Steinberg and colleagues (2008): "Heightened vulnerability to risk-taking in middle adolescence may be due to the combination of relatively higher inclinations to seek excitement and relatively immature capacities for self-control that are typical of this period of development" (pg.1764). In this statement, the details about the specific ages studied, the *inscription devices* used, the *dissidence* of the behavioural measure of sensation seeking, and more, fall back from the centre of focus. Adolescence becomes characterized by the behaviours of risk taking and impulsivity which are determined by neurological development. However, even the detail in this definition of adolescence fades when it is taken up by the *amicus briefs*. More details of the research fall to the background as the neurologized adolescent actor-network molecule becomes a scientific fact.

The research from Steinberg and colleagues (2008) represents one of many resources relied on in the *amicus briefs* to produce a statement on adolescence for the Supreme Court. Their statement becomes *black boxed*, along with other statements from other research, in order to present a new, modified, and clear statement to be presented to the Supreme Court. In the case of the briefs submitted by the AMA in both Supreme Court cases, the new statement is clear and simple: "The adolescent's mind works differently from ours" (AMA, 2009, pg.2; 2012, pg.2). All of the details and components that make up the network of connections in the Steinberg and colleagues (2008) paper are removed, fading to the background as they are not of importance

anymore. The briefs do not need to provide the Supreme Court with the measures and the participants and the details of how the brain or personality develops. They simply need to inform the court of their psychological or medical stance on the development of adolescents. This main statement about adolescents informs the court that youth are different from adults and need to be treated as such. The adolescent is neurologized as the focus of the difference between children and adults is the mind. The mind makes all the difference in how adolescents behave and how they ought to be treated.

The *amicus briefs* submitted by the APA in both Supreme Court cases is more specific, but still focuses only on the information pertinent for the Court to make a decision. The APA briefs referred back to the *Roper v. Simmons* (2005) case, saying that developing research in neuroscience and psychology confirm that "…the three developmental characteristics of juveniles that *Simmons* identified – their immaturity, their vulnerability, and their changeability – render them, as a group, very different from adults" (APA, 2009, pg.6; 2012, pg.7). More detail is retained in this statement from the APA, however the main takeaway again is that adolescents are different from adults. This difference is related back to the mind as they identify immaturity, vulnerability, and changeability as the causes of this difference. Adolescence is no longer just a period of development between childhood and adulthood, but a neurologically defined period of development that makes them deserving of specialized treatment. The adolescent is further neurologized and has now become defined in these *amicus briefs* by the development of their mind.

In this first step of Callon's third translation, the adolescent molecule produced in the research paper is positively *modalized*, modified to fit the needs of the *amicus briefs*, and gains solidity. It has become *black boxed* in the briefs, cited and referenced as a certainty, a fact.

Challenging the statement is to challenge the authority of the AMA and the APA on matters of psychological and neurological development. As the statement gains solidity and is modified, the adolescent becomes more neurologized. The belief that adolescent behaviour is caused by the mind, and more specifically the development of the mind, becomes more solidified in the knowledge base, more truthful, more certain. We will see both of these components progress even further in the second step of the translation, where the statement is displaced from the *amicus briefs* to the Supreme Court opinions.

### 1.11.3. Displacing the Adolescent from the Scientific Community to the Legal System

The second step in which the Steinberg and colleagues' (2008) research takes part in Callon's third translation is from the supporting court documents to the Supreme Court opinions. The scientific article and statement that was translated to and referenced in the *amicus briefs* submitted by the AMA and APA were then translated from these documents and referenced in the court opinions submitted for each case. This step of the translation also sees the statements being positively *modalized*, gaining solidity, and further neurologizing the adolescent. I explore this second step here.

Law, like the APA and AMA groups, acts as an authority on knowledge and truth, but in a different way. It has been noted that science and law can be considered the two most powerful truth-producing institutions (Cole & Bertenthal, 2017, pg.352). The law is what determines the right and the wrong in society. Law determines how to deal with people who do things that are wrong. Law relies on scientific evidence, what is considered common sense, and evolving standards of decency in order to decide these things (Fallon, 2012). In this sense, law plays a large role in establishing what is identified as fact, in determining what is to be taken as accurate

scientific knowledge (Cole & Bertenthal, 2017, pg.358). Law, in making judicial decisions, co-produces with science. It plays a role in establishing what science is reliable (Cole & Bertenthal, 2017, pg.359), and what is not. Thus, to be referenced by the law through a positive *modality* is to be reinforced as fact. On the other hand, to be ignored or refuted by the law is to be identified as inaccurate, untruthful, or simply not practically useful.

The Steinberg and colleagues (2008) scientific text is referenced in the court opinions through the *amicus briefs*. The article became *black boxed* in the briefs and became part of the briefs' main arguments about adolescence. These arguments were then taken up by the court in their decisions. The statements were positively *modalized* by the court opinions, as well as the concurring justices' opinions. The court opinions emphasize that "juveniles have a lack of maturity and an underdeveloped sense of responsibility…their characters are not as well formed" (Wagner, 2009, pg.68). There is a certainty in the way that the court references the information and knowledge from the *amicus briefs*. There is no *hedge* such as 'it is possible that', or 'some research finds'. When the court speaks about the research, it is in terms of facts, of what we know about adolescence. They are not debating the science, they are simply relying on it to help them make the sentencing decision. Therefore, any research they rely on is considered to be factual and based on concrete evidence. By being part of these major legal decisions, the research from Steinberg and colleagues (2008) becomes even more *black boxed* and gains even more solidity. The court is so certain of the research, there is no need to move upstream to study the evidence presented by the *amicus briefs*, the court moves away from the production of the adolescent molecule to solidify the facts about adolescence.

These facts on adolescence are considered to be very well known. For example, when describing the reason for the decision in *Graham v. Florida* (2009), the court said that "…the

differences between juvenile and adult offenders are too marked and well understood…" (Wagner, 2009, pg.78). They argue that retaining the life without parole sentence would be ignoring the research and knowledge on adolescence that is so well known. This reinforces the knowledge disseminated from the Steinberg and colleagues (2008) scientific text and the *amicus briefs* as certain. The statement from the article gains solidity through this translation. What began as a lone statement on adolescence has become part of a large network of connections, holding its solidity intact.

These quotes were taken solely from the *Graham v. Florida* (2009) cases, however the same pattern can be seen in the *Miller v. Alabama* (2012) court opinions. In the court opinions for this case, again there is certainty around the knowledge of adolescence. The court is sure of the research it is referencing, and this research forms the basis of the decisions they make and the conclusions they draw. The opinions reference the research in a way that makes this clear by stating that "…because a child's character is not as well formed as an adult's…" (Fallon, 2012, pg.461), they are more likely to be able to be rehabilitated. Again, in this case, there is no *hedging,* no moving upstream towards the methods of production. It is only positive *modalizations* of the research that are seen here. There is no questioning of whether we can be sure the character is well formed or not, it is simply a matter of fact. The child's character is different, and because this is known to be true, further conclusions can be drawn. The statements put forth by the *amicus briefs* are known to be factual, therefore the statements put forth by those referenced in the briefs, including Steinberg and colleagues (2008) are also known to be factual. The statement about adolescence concluded in the scientific article becomes *black boxed* further and gains more solidity. There is no contending with the statement, there is only referencing it to

make further conclusions. The authority of the Court justices has been added as an ally mobilized to solidify the facticity of the neurologized adolescent molecule.

On top of the way in which the statements are *modalized*, there is also the pattern, seen with the *amicus briefs*, of information remaining relevant and accurate over time. Just as the briefs repeated the same information, referencing the same sources in *Graham v. Florida* (2009) as in *Miller v. Alabama* (2012), the courts also note a consistency in the scientific knowledge base on adolescence over time. The *Graham v. Florida* (2009) court opinions note that "No recent data provide reason to reconsider the Court's observations in *Roper* about the nature of juveniles" (Wagner, 2009, pg.68). Three years later, in the *Miller v. Alabama* (2012) court opinions, it is noted that "Everything we said in *Roper* and *Graham* about that stage of life also appears in these decisions" (Fallon, 2012, pg.476). The relevant knowledge has remained constant for years. While new research had been published and referenced since the *Roper v. Simmons* (2005) case – such as the Steinberg and colleagues (2008) paper – the knowledge disseminated from these sources has remained constant. The strength of the connections in this network has held for many years. At some point in time the court could decide to rely on different research – they could become *dissidents* in the actor-network – and the adolescent molecule could lose this ally, but for the time being, the adolescent molecule holds the connection to the legal system well. There is strength in gaining solidity, something the article published by Steinberg and colleagues (2008) has done well.

In addition to the solidity being gained by the statement, I also want to reinforce the neurologization of the adolescent through this second step of the translation. First, to once again reiterate the statement that was produced from the Steinberg and colleagues (2008) text: "Heightened vulnerability to risk-taking in middle adolescence may be due to the combination of

relatively higher inclinations to seek excitement and relatively immature capacities for self-control that are typical of this period of development" (1764). As this statement was translated to the *amicus briefs,* the statement was modified and the adolescent became more neurologized. The AMA briefs reported that "The adolescent's mind works differently from ours" (AMA, 2009, pg.2; 2012, pg.2), while the APA briefs reported that "…the three developmental characteristics of juveniles that *Simmons* identified – their immaturity, their vulnerability, and their changeability – render them, as a group, very different from adults" (APA, 2009, pg.6; 2009, pg.7). There is uncertainty in the original statement. The authors of the scientific article use *hedges* to humbly report their findings, leaving room for some doubt. The authors claim that adolescent behaviour *may be* due to the development of sensation seeking and impulse control. Therefore, the neurologized adolescent molecule is not yet stable. The *amicus briefs* then become more certain and clearer. Adolescents are different and it is because of these developmental characteristics. The adolescent is becoming neurologized, becoming defined by neuroscience in more and more certain terms.

In the court opinions, these ideas about adolescence become more solidified and this further neurologizes the adolescent. The conclusion on adolescent behaviour from the courts is that juveniles are impulsive and have "…difficulty thinking in terms of long-term benefits…" (Wagner, 2009, pg.51). This knowledge on adolescents means that they are "…constitutionally different from adults for sentencing purposes" (Fallon, 2012, pg.461). The facts from the field of neuroscience and developmental psychology are so certain that the Supreme Court confidently declares adolescents as *constitutionally* different from adults. Because the adolescent is neurologized, because this information is known, the Supreme Court can make decisions based on the knowledge of the neurologized adolescent molecule as a fact. They are reinforcing the

knowledge disseminated from the research and the *amicus briefs*. The law, as a truth-producing institution, is confirming the knowledge of adolescence as a time of development, involving immaturity, and determining adolescents to be a separate, recognized group under the law. The behaviour of adolescents is understood completely in terms of the development of their brain and mind. The adolescent has become more neurologized. No longer is the adolescent defined by a need for protection or defined as dangerous as was the case at different points of time in the past. The adolescent is defined by their lack of cognitive development. The neurologized adolescent actor-network molecule is long and strong.

This neurologization of adolescence allows the court to determine, with conviction, that "…juveniles have lessened culpability…" (Wagner, 2009, pg.50). From a tentative statement about adolescence as a period of increased sensation seeking and impulsivity, to confirmatory beliefs about adolescents as a separate group from adults, and finally to a group defined by their diminished moral culpability because of their mind, the molecule from the Steinberg and colleagues (2008) text was translated. It was displaced from the science laboratory to the outside world, where it gained solidity by creating alliances with the legal system. Graham (2009, pg.380) claims that a network will gain solidity when it is maintained by authoritative structures. The authority of the APA, the AMA, and the United States Supreme Court solidified the facticity of the statement. Along this process of translation, the adolescent as an actor-network became more and more defined by neuroscientific research and studies. Adolescence became more and more associated with the sciences of the mind, both neuroscience and developmental psychology. The adolescent became neurologized while the statement gained solidity, through the authority of law.

# CONCLUSION – THE NEUROLOGIZED ADOLESCENT MOLECULE

This thesis has examined how science produces facts, specifically how neuroscience provided solidity to the Steinberg and colleagues (2008) scientific article. This, in turn, has shown how the adolescent is neurologized through its actor-network in the fields of science and law. I have attempted to answer the question of how neuroscience is applied to and transforms the adolescent in reality. In order to accomplish this, I first presented an overview of the scientific literature on adolescence, and the literature available on the definition of adolescence in law and how the treatment of adolescents in the criminal justice system has progressed over time.

I chose to use ANT as a theoretical background for the project, which evolved from the field of the sociology of science. For this reason, I provided an overview of the literature on different sociologies of science. I then presented a section on American Pragmatism, the relational view of science I took in this thesis. I followed this with a description of ANT and how I would be studying translation. I also included two criticisms of ANT, along with explanations as to why ANT remained a good choice for my project despite these criticisms. I limited the analysis to a case study of one scientific article published by Steinberg and colleagues (2008) and documents involved in two United States Supreme Court cases related to that scientific article. Using concepts from ANT, I was able to describe the actor-network produced from Steinberg and colleagues' (2008) laboratory and how that network was translated and solidified in science and law.

I supported this through a three part analysis, where I described the strong network of connections around the neurologized adolescent molecule. Solidity is gained through long, strong networks of facts, objects, people, institutions, and other actors in the network (Graham, 2009, pg.382). This solidity, in turn, ensures that the adolescent is neurologized. Since neuroscience plays a large role in the network's solidity and acceptance as fact in law, the adolescent becomes defined through neuroscience, and is thus, neurologized. In my analysis I highlighted three types of translations that occurred in order to produce and solidify the neurologized adolescent molecule. It demonstrates the coordination of actors and translations required to produce the neurologized adolescent molecule.

The first of Callon's translations that I described was the second, that of displacements and movements occurring within the laboratory (Callon, 2003). I described the moments of translations that occurred within the laboratory which allowed the researchers to pursue a neurologized definition of adolescence and how this neurologized explanation of adolescence provided solidity to the statement. Through this translation, we see the adolescent molecule becoming growing, garnering solidity, and becoming neurologized.

The second translation encountered was Callon's first translation, that of translating an entity from the outside, macrocosm of the world, to the microcosm of the laboratory (Callon, 2003). The adolescent was brought from the outside world into the laboratory through the actors of sensation seeking and impulsivity. This identification of two separate actors provided solidity to the scientific statement produced in the scientific text and neurologized the adolescent entity further.

The last of Callon's translations described, the third translation is that of moving from the microcosm of the laboratory to the outside, macrocosm of the world (Callon, 2003). The neurologized adolescent molecule gained more allies, this time outside of the laboratory and the field of science. Through this translation, we see the adolescent molecule becoming stronger and more interconnected. The network gains more solidity, and the adolescent is even further neurologized.

I have evidently described the neurologized adolescent molecule through these three translations. At each translation, something is added to the network and the network becomes longer and stronger, thus adding to the strength of its solidity. At each translation, the adolescent molecule also becomes further neurologized. More emphasis was placed on the neuroscientific method of explaining adolescence, and more allies confirmed this explanation. Unlike in the past where the adolescent was defined as dangerous or a youth in need of protection, the adolescent became defined through neuroscience. After the final translation, the network has been described as complex, interconnected, and riddled with *enrolled* actors and allies. Facticity and the neurologization of the adolescent entity are strengthened and ongoing.

As we live in a time when society is taking a neuro-turn, where neuroscience acts as a cultural authority over the explanation of behavioural phenomena (Schneider & Woolgar, 2015), this thesis is essential in contributing to our understanding of neuroscience as an important actor in defining adolescence. It is an important time to study neurologization, not just of adolescence, but neurologization in general. During this neuro-turn, the legal system has become increasingly reliant on neuroscience and fMRI evidence to make decisions in the criminal justice system (Aronson & Cole, 2009). Neuroscience research, techniques, and tools are being taken very seriously in the United States Supreme Court, as demonstrated in this thesis, but also in lower

courts where fMRI scans are presented at trial and are expected to carry a lot of weight. This thesis is a necessary exploration to understand how this neuro-turn in society is being embraced in law and how this type of scientific work produces truths around adolescent behaviour. Further research of this kind may help to augment our understanding of the authority held by neuroscience in law, and in the public mind more generally.

Knowledge produced from the field of neuroscience is given a large amount of authority in the legal and criminal justice system. Understanding the process through which this knowledge gains facticity and how we come to rely on its authority in law is crucial to the objective of democratizing science. It is important that we are able to understand what knowledge, what tools, and what techniques are being assigned authority in law, an institution in itself that already holds so much authority over what is truth and what is right. Scientific work is fragile and complex and intricate. The objective of democratization is not to tear science down, but to bring it down from the pedestal on which we have placed it. Rather than regarding a nature that is separate from humans and is unreachable, and scientists as the few mediums through which we can study nature, democratizing science means seeing science for what it is, a social work that involves many actors coming together and producing a network. By slowly and carefully moving, metaphorically, through the laboratory we can begin to see the true scientific work, the social work of science. We can begin to see the networks being formed, strengthened, lengthened, and severed. We can see how science produces truths that become part of reality and function in reality. We can begin to understand the beautiful details of the work being done in science and we can appreciate it for what it is and how it is practically helpful.

In this thesis I have actualized the relational model of science to study the scientific process of fact production. I have described movements within the science laboratory where

every moment that builds connections builds a stronger network of relations, thus providing certainty and solidity to the network itself. Through this model I have described the work of scientists, where the researchers contribute to the solidity of the work as much as the other actors within the network, as much as the material objects contribute to the work. From their correspondence perspective, the scientists are working to 'discover' truths about nature. But, from this relational perspective, the scientists, along with all the other actors in the network, are working together to produce truths about reality, a reality in which the natural, social, political, cultural, and material world are interconnected.

By using a relational model to understand scientific work I am able to present a critical description of science and the process of fact production within science. This is a different type of contribution to the field of criminology than the more classic understand of what it means to be critical. A thesis that contributes to the study of neurologization from a critical criminological perspective may be one that condemns science, criticizes it from the inside, aims to look for the problems in scientific work in order to be able to transform how the work is done, to improve it. A classic critical approach may be interested in studying how neurologization leads to deterministic thinking where everything is determined by genetics or neurons and no one has any say in their behaviour. It may also look to neurologization and ask questions of why the studies do not account for different factors that may be involved other than brain development, genetics, or neurons. It may seek to study the social and cultural aspects of science as a way to 'expose' that science is not objective and therefore knowledge from science could not be trusted. However, the relational approach I take allows me to show the work, to open science up so that it is observable, so that we can see the intricate social and political work of science.

The interest of using the relational view for this thesis is to democratize science. In adopting this relational view, I am not condemning science for being social or unobjective. I aim to democratize science, to remove it from its position as an unreachable and untouchable authority over truths. I describe the social and cultural aspects of science in an attempt to convince the reader that truth and reality are intertwined in social life, that scientists and science laboratories are part of an ever-continuing process of producing truths and reality. It is to understand that everything that is, everything we know, is produced and continues to be produced through social, political, and cultural transformations and movements. It is to understand that the connections built and maintained are what produce reality, that, as Latour says, the more something is constructed, the more it is real. The more social, political, cultural, and material actors involved in the network, the more it grows and the stronger it becomes. This relational view is used to understand how things are built, how truths are built, and I specifically aim to demonstrate this process in the case of Steinberg and colleagues (2008) work in neurologizing adolescence.

In completing this thesis, I participate not only in democratizing science, but also in the neurologized adolescent actor-network itself. I become an actor that is now connected to the other actors in the network. I am connected to the materials I read including the Steinberg and colleagues (2008) article, the court opinions, and the *amicus briefs*. I am now an actor *enrolled* within the network having a special role. I am an actor that performs the network. I connect with it and I make it live as part of reality. I am acknowledging this scientific text's existence as well as many of the actors connected to it, and I am showing the work. I am performing the network into existence through my critical description of the production and solidification of the neurologized adolescent.

The adolescent actor-network that I have described may become longer and stronger, or it may face *dissidence* in the future. It may find some of its actors' identities failing and pulling away, or it may find more actors and allies to *enroll* in other fields. At this moment, the scientific work has reached its goals – to define adolescence through neuroscience and have that definition taken up as reality. In this process, the research intervened in the natural and the social world. The product of the scientific research can no longer be perceived as the natural world being 'discovered' by science, but can now be seen for what it is – a cultural and social entity (Knorr-Cetina, 1995). In viewing the Steinberg and colleagues (2008) article this way, science is democratized. It is no longer about taking what is said from scientists simply as fact, but understanding the process through which the research, the researchers, and the statement move in order to grow an actor-network in the process of producing truths and thus contributing truths to reality.

# REFERENCES

Adriani, W., & G. Laviola. (2016). Commentary on the special issue "The Adolescent Brain": How can we run operant paradigms in a preclinical adolescent model? Technical tips and future perspectives. *Neuroscience & Biobehavioral Reviews, 70*: 323-328. doi: 10.1016/j.neubiorev.2016.07.028

Advocate, D.L. (1998). The Paradigm: Thomas Kuhn and the Trojan Horse. Eos, Transactions, *American Geophysical Union, 79*(5): 62.

American Medical Association (AMA). 2009 WL 2247127 U.S. (Appellate Brief). No. 08-7412, 08-7621.

American Medical Association (AMA). 2012 WL 121237 U.S. (Appellate Brief). No. 10-9646, 10-9647.

American Psychological Association (APA). 2009 WL 2236778 U.S. (Appellate Brief). No. 08-7412, 08-7621.

American Psychological Association (APA). 2012 WL 174239 U.S. (Appellate Brief). No. 10-9646, 10-9647.

Anderson, S.L. (2016). Commentary on the special issue on the adolescent brain: Adolescence, trajectories, and the importance of prevention. *Neuroscience & Biobehavioral Reviews, 70*: 329-333. doi: 10.1016/j.neurobiorev.2016.07.012

Aronson, J.D., & S.A. Cole (2009). Science and the Death Penalty: DNA, Innocence, and the Debate over Capital Punishment in the United States. *Law & Social Inquiry, 34*(3): 603-633.

Arthur, R. (2017). *The Moral Foundations of the Youth Justice System: Understanding the principles of the youth justice system*. New York, NY: Routledge.

Baird, M.I., & M.B. Samuels. (1996). Justice for Youth: The Betrayal of Childhood in the United States. *Journal of Law & Policy, 5*: 177-202.

Bernard, T.J., & M.C. Kurlychek. (2010). *The Cycle of Juvenile Justice* (2nd edition). New York, NY: Oxford University Press.

Bertotti, A.M., & S.A. Miner. (2019). Constructing contentious and noncontentious facts: How gynecology textbooks create certainty around pharma-contraceptive safety. *Social Studies of Science, 49*(2): 245-263. doi: 10.1177/0306312719834676

Blakemore, S. (2012). Development of the social brain in adolescence. *Journal of the Royal Society of Medicine, 105*: 111-116. doi: 10.1258/jrsm.2011.110221

Bloor, D. (1999). Anti-Latour. *Studies in History & Philosophy of Science, 30*(1): 81-112.

Boisvert, R. (2012). Whither Pragmatism? *The Pluralist, 7*(3): 107-119.

Callon, M. (1986). Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay. In J. Law (ed.) *Power, Action, & Belief: a new sociology of knowledge?* (196-223). London: Routledge.

Callon, M. (1995). Four Models for the Dynamics of Science. In S. Jasanoff, G.E. Markle, J.C. Petersen, & T. Pinch (revised edition), *Handbook of Science and Technology Studies* (29-63). SAGE Publications, Inc.

Callon, M. (2003). Science et Société : Les Trois Traductions. *Cahier du Mouvement Universel de la Responsibilité Scientifique, 42* : 52-69.

Casey, B.J., Galvan, A., & T.A. Hare. (2005). Changes in cerebral functional organization during cognitive development. *Current Opinion in Neurobiology, 15*: 239-244.

Casey, B.J., Getz, S., & A. Galvan. (2008). The adolescent brain. *Developmental Review, 28*: 62-77. doi: 10.1016/j.dr.2007.08.003

Casey, B.J., & R.M. Jones. (2010). Neurobiology of the Adolescent Brain and Behavior. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(12): 1189-1285. doi: 10.1016/j.jaac.2010.08.017

Chambers, R.A., Taylor, J.R., & M.N. Potenza. (2003). Developmental Neurocircuitry of Motivation in Adolescence: A Critical Period of Addiction Vulnerability. *American Journal of Psychiatry, 160*(6): 1041-1052.

Cloninger, C.R., Przybeck, T.R., & D.M. Svrakic. (1991). The Tridimensional Personality Questionnaire: U.S. Normative Data. *Psychological Reports, 69*: 1047-1057.

Cole, S.A., & A. Bertenthal. (2017). Science, Technology, Society, and Law. *Annual Review of Law & Social Science, 13*: 351-371. doi: 10.1146/annurev-lawsocsci-110316-113550

Coopman, C., Vertesi, J., Lynch, M., & S. Woolgar. (2014). How (Not) to Do Things with Brain Images. In *Representation in Scientific Practice Revisited* (291-314). MIT Press. doi: 10.7551/mitpress/9780262525381.003.0014

Cronin, B. (2004). Normative shaping of scientific practice: The magic of Merton. *Scientometrics, 60*(1): 41-46.

Dahl, R.E. (2004). Adolescent Brain Development: A Period of Vulnerabilities and Opportunities. *Annals of the New York Academy of Sciences, 1021*: 1-22. doi: 10.1196/annals.1308.001

Depue, R.A., & P.F. Collins. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral & Brain Sciences, 22*: 491-569.

Dickman, S.J. (1990). Functional and Dysfunctional Impulsivity: Personality and Cognitive Correlates. *Journal of Personality & Social Psychology, 58*(1): 95-102.

Dornbusch, S.M. (1989). The Sociology of Adolescence. *Annual Review of Sociology, 15*: 233-259.

Drevets, W.C., & M.E. Raichle. (1998). Reciprocal Suppression of Regional Cerebral Blood Flow during Emotional versus Higher Cognitive Processes: Implications for Interactions between Emotion and Cognition. *Cognition & Emotion, 12*(3): 353-385.

Dufresne, M. (2015). How Does a Gene in a Scientific Journal Affect my Future Behavior? In D. Robert & M. Dufresne, *Actor Network Theory and Crime Studies: Explorations in Science and Technology*. (37-50). Taylor & Francis Group.

Dufresne, M., & D. Robert. (2017). La Biographie d'un Gène. *Déviance et Société, 41*(4): 593-619. doi: 10.3917/ds.414.0593

Durston, S., Davidson, M.C., Tottenham, N., Galvan, A., Spicer, J., Fossella, J.A., & B.J. Casey. (2006). A shift from diffuse to focal cortical activity with development. *Developmental Science, 9*(1): 1-20.

Edge, D. (1995). Reinventing the Wheel. In S. Jasanoff, G.E. Markle, J.C. Petersen, & T. Pinch (revised edition), *Handbook of Science and Technology Studies* (3-24). SAGE Publications, Inc.

Ellison, W.J. (1987). State Execution of Juveniles: Defining "Youth" as a Mitigating Factor for Imposing a Sentence of Less than Death. *Law & Psychology Review, 11*: 1-38.

Ernst, M., Nelson, E.E., Jazbec, S., McClure, E.B., Monk, C.S., Leibenluft, E., Blair, J., & D.S. Pine. (2005). Amygdala and nucleus accumbens in responses to receipt and omission of gains in adults and adolescents. *NeuroImage, 25*: 1279-1291. doi: 10.1016/j.neuroimage.2004.12.038

Eysenck, S.B.G., & H.J. Eysenck. (1977). The place of impulsiveness in a dimensional system of personality description. *British Journal of Social & Clinical Psychology, 16*: 57-68.

Eysenck, S.B.G., & H.J. Eysenck. (1978). Impulsiveness and Venturesomeness: Their Position in a Dimensional System of Personality Description. *Psychological Reports, 43*: 1247-1255.

Fallon, C.L. [Reporter of Decisions] (2012). Cases Adjudged in The Supreme Court at October Term, 2011. Docket No. 10-9646 (Court Opinions). Pgs. 460-518.

Farley, F., & S.V. Farley. (1967). Extroversion and Stimulus-Seeking Motivation. *Journal of Consulting Psychiatry, 31*(2): 215-216.

Felsman, J.P. (1996). Eliminating Parental Consent and Notification for Adolescent HIV Testing: A Legitimate Statutory Response to the AIDS Epidemic. *Journal of Law & Policy, 5*: 339-383.

Fischer, M.M. (2007). Four Genealogies for a Recombinant Anthropology of Science and Technology. *Cultural Anthropology, 22*(4): 539-615. doi: 10.1525/can.2007.22.4.539

François, K. (2011). In-Between Science and Politics. *Foundations of Science, 16*: 161-171. doi: 10.1007/s10699-010-9195-6

Fuller, S. (2006). *The Philosophy of Science and Technology Studies*. New York, NY: Taylor & Francis Group.

Galvan, A., Hare, T.A., Parra, C.E., Penn, J., Voss, H., Glover, G., & B.J. Casey. (2006). Earlier Development of the Accumbens Relative to Orbitofrontal Cortex Might Underlie Risk-Taking Behavior in Adolescents. *The Journal of Neuroscience, 26*(25): 6885-6892.

Galvan, A., Hare, T., Voss, H., Glover, G., & B.J. Casey. (2007). Risk-taking and the adolescent brain: who is at risk? *Developmental Science, 10*(2): F8-F14. doi: 10.1111/j.1467-7687.2006.00579.x

Giardino, L.F. (1996). Statutory Rhetoric: The Reality Behind Juvenile Justice Policies in America. *Journal of Law & Policy, 5*: 223-276.

Gorur, R. (2011). ANT on the PISA Trial: Following the statistical pursuit of certainty. *Educational Philosophy & Theory, 43*(1): 76-93. doi: 10.1111/j.1469-5812.2009.00612.x

Graham, S.S. (2009). Agency and the Rhetoric of Medicine: Biomedical Brain Scans and the Ontology of Fibromyalgia. *Technical Communication Quarterly, 18*(4): 376-404. doi: 10.1080/10572250903149555

*Graham v. Florida*. (2009). WL 3731318 U.S. (Oral Argument). No. 08-7412.

Guyer, A.E., Silk, J.S., & E.E. Nelson. (2016). The neurobiology of the emotional adolescent: From the inside out. *Neuroscience & Biobehavioral Reviews, 70*: 74-85. Doi: 10.1016/j.neubiorev.2016.07.037

Hartwick, E.R. (2000). Towards a geographical politics of consumption. *Environment & Planning A, 32*: 1177-1192. doi: 10.1068/a3256

James, W. (n.d.). Chapter II: A World of Pure Experience. In *Essays in Radical Empiricism* (21-44). Raleigh, NC: Generic NL Freebook Publisher.

James, W. (1911). *The Meaning of Truth: A Sequel to Pragmatism* (first edition). New York, NY: Greenwood Press Publishers.

James, W. (1988). *Pragmatism* (fourth edition). B. Kuklick (ed). Indianapolis, IN: Hackett Publishing Company Inc.

Kiesner, J., & M. Kerr. (2004). Families, peers, and contexts as multiple determinants of adolescent problem behaviour. *Journal of Adolescence, 27*: 493-495. doi: 10.1016/j.adolescence.2004.06.004

Knorr-Cetina, K. (1995). Laboratory Studies: The Cultural Approach to the Study of Science (revised edition). In S. Jasanoff, G.E. Markle, J.C. Pattersen, & T. Pinch (eds.) *Handbook of Science and Technology Studies* (140-166). Thousand Oaks: SAGE Publications Inc.

Kuklick, B. (1988). Introduction. In B. Kuklick (ed). *Pragmatism* (fourth edition) (ix-xv). Indianapolis, IN: Hackett Publishing Company Inc.

Latour, B. (1992). One More Turn after the Social Turn: Easing Science Studies into the Non-Modern World. In E. McMullin, *The Social Dimensions of Science* (272-292). Notre Dame University Press.

Latour, B. (1987a). Literature. In *Science in Action: How to Follow Scientists and Engineers Through Society,* (21-62). Cambridge: Harvard University Press.

Latour, B. (1987b). Laboratories. In *Science in Action: How to Follow Scientists and Engineers Through Society,* (63-100). Cambridge: Harvard University Press.

Latour, B. (1992). One More Turn after the Social Turn: Easing Science Studies into the Non-Modern World. In E. McMullin (ed.) *The Social Dimensions of Science* (272-292). Notre Dame: Notre Dame University Press.

Latour, B. (1996). On actor-network theory. A few clarifications plus more than a few complications. *Sociale Weltz, 47*: 369-381.

Latour, B. (1999). Circulating Reference: Sampling the Soil in the Amazon Forest. In *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge: Harvard University Press.

Latour, B. (2004). Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern. *Critical Inquiry, 30*: 225-248.

Latour, B., & P. Fabbri. (1977). La rhétorique de la science: Pouvoir et devoir dans un article de science exacte. *Actes de la Recherche en Science Sociales, 13*: 81-95. doi: 10.3406/arss.1977/3496

Latour, B., & P. Fabbri. (2000). The Rhetoric of Science: Authority and Duty in an Article from the Exact Sciences. *Technostyle, 16*(1): 115-134.

Law, J. (2002). Objects and Spaces. *Theory, Culture, & Society, 19*(5/6): 91-105.

Law, J. (2009). Actor Network Theory and Material Semiotics. In B.S. Turner, *The New Blackwell Companion to Social Theory* (141-158). Blackwell Publishing Ltd.

Law, J., & V. Singleton. (2014). ANT, multiplicity and policy. *Critical Policy Studies, 8*(4): 379-396. doi: 10.1080/19460171.2014.957056

Ledford, H. (2018). The Shifting Boundaries of Adolescence. *Nature, 554*: 429-431.

Loeber, R. (2012). Does the Study of the Age-Crime Curve Have a Future? In R. Loeber & B.C. Welsh (eds.) *The Future of Criminology* (pgs.11-19). Oxford University Press.

Macfarlene, B., & M. Cheng. (2008). Communism, Universalism and Disinterestedness: Re-examining Contemporary Support among Academics for Merton's Scientific Norms. *Journal of Academic Ethics, 6*: 67-78. doi: 10.1007/s10805-008-9055-y

Martin, B.R., Nightingale, P., & A. Yegros-Yegros. (2011). Science and Technology Studies: Exploring the Knowledge Base. *Centre for Business Research, Working Paper #427*: 2-65.

Mays, L., & L.T. Winfree Jr. (2006). *Juvenile Justice* (2nd edition). Long Grove, IL: Waveland Press Inc.

McClure, S.M., Laibson, D.I., Loewenstein, G., & J.D. Cohen. (2004). Separate neural systems value immediate and delayed monetary rewards. *Science, 306*(5695): 503-509.

*Miller v. Alabama.* (2012). WL 928359 U.S. (Oral Argument). No. 10-9646.

Modecki, K.L. (2008). Addressing Gaps in the Maturity of Judgement Literature: Age Differences and Delinquency. *Law & Human Behavior, 32*: 78-91. doi: 10.1007/s10979-007-9087-7

Monahan, K.C., Steinberg, L., & E. Cauffman. (2009). Affiliation With Antisocial Peers, Susceptibility to Peer Influence, and Antisocial Behavior During the Transition to Adulthood. *Developmental Psychology, 45*(6): 1520-1530. doi: 10.1037/a0017417

Nelson, E.E., Leibenluft, E., McClure, E.B., & D.S. Pine. (2004). The social re-orientation of adolescence: a neuroscience perspective on the process and its relation to psychopathology. *Psychological Medicine, 35*: 163-174. doi: 10.1017/S0033291704003915

Office of Juvenile Justice and Delinquency Prevention, OJJDP. (2012). Statistical Briefing Book: Juveniles Tried as Adults. Retrieved from https://www.ojjdp.gov/ojstatbb/structure_process/qa04105.asp?qaDate=2011

Patton, J.H., Stanford, M.S., & E.S. Barratt. (1995). Factor Structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology, 51*(6): 768-774.

Patton, G.C., Olsson, C.A., Skirbekk, V., Saffery, R., Wlodek, M.E., Azzopardi, P.S., Stonawski, M., Rasmussen, B., Spry, E., Francis, K., Bhutta, Z.A., Kassebaum, N.J., Mokdad, A.H., Murray, C.J.L., Prentice, A.M., Reavley, N., Sheehan, P., Sweeny, K., Viner, R.M., & S.M. Sawyer. (2018). Adolescence and the next generation. *Nature, 554*: 458-472.

Pautassi, R.M., Myers, M., Spear, L.P., Molina, J.C., & N.E. Spear. (2008). Adolescent, but not adult, rats exhibit ethanol-mediated appetitive second-order conditioning. *Alcoholism: Clinical & Experimental Research, 32*(11): 2016-2027. doi: 10.1111/j.1530-0277.2008.00789.x

Raznahan, A., Shaw, P., Lalonde, F., Stockman, M., Wallace, G.L., Greenstein, D., Clasen, L., Gogtay, N., & J.N. Giedd. (2011). How Does Your Cortex Grow? *The Journal of Neuroscience, 31*(19): 7174-7177. doi: 10.1523/jneurosci.0054-11.2011

Restivo, S. (1995). The Theory Landscape in Science Studies: Sociological Traditions. In S. Jasanoff, G.E. Markle, J.C. Petersen, & T. Pinch (revised edition), *Handbook of Science and Technology Studies* (95-110). SAGE Publications, Inc.

Reuter, E.B. (1937). The Sociology of Adolescence. *American Journal of Sociology, 43*(3): 414-427.

Rich, G.J. (2003). The Positive Psychology of Youth and Adolescence. *Journal of Youth & Adolescence, 32*(1): 1-3.

Richter, L.M. (2006). Studying Adolescence. *Science, 312*(5782): 1902-1905.

Rohracher, H. (2015). Science and Technology Studies, History of. *International Encyclopedia of the Social & Behavioral Sciences, 21*: 200-205. doi: 10.1016/B978-0-08-097086-8.03064-6

*Roper v. Simmons.* (2005). 125 S.Ct. 1183.

Ruschoff, B., Dijkstra, J.K., Veenstra, R., & S. Lindenberg. (2015). Peer status beyond adolescence: Types and behavioral associations. *Journal of Adolescence, 45*: 1-10. doi: 10.1016/j.adolescence.2015.08.013

Sayes, E. (2017). Marx and the critique of Actor-Network Theory: mediation, translation, and explanation. *Distinktion: Journal of Social Theory, 18*(3): 294-313. doi: 10.1080/1600910X.2017.1390481

Schaffer, S. (1991). The Eighteenth Brumaire of Bruno Latour. *Studies in History & Philosophy of Science, 22*(1): 174-192.

Schneider, T., & S. Woolgar. (2015). Neuroscience beyond the laboratory: Neuro knowledges, technologies, and markets. *Biosocieties, 10*(4): 389-399.

Scott, E. (2000). The Legal Construction of Adolescence. *Hofstra Law Review, 29*: 547-598.

Scott, E., Grisso, T., Levick, M., & L. Steinberg. (2015). The Supreme Court and the Transformation of Juvenile Sentencings. *Models for Change: Systems Reform in Juvenile Justice.*

Shoemaker, D.J., & T.W. Wolfe. (2016). *Juvenile Justice: A Reference Handbook* (2nd edition). Santa Barbara, CA: ABIO-CLIO LLC.

Skowroński, K.P. (2011). Democratic Values in the Aesthetics of Classic American Pragmatism. *Human Affairs, 21*: 335-346. doi: 10.2478/s13374-011-0035-3

Small, H. (2004). On the shoulders of Robert Merton: Towards a normative theory of citation. *Scientometrics, 60*(1): 71-79.

Soto, C.J., & J.L. Tackett. (2015). Personality Traits in Childhood and Adolescence: Structure, Development, and Outcomes. *Current Directions in Psychological Science, 24*(5): 358-362. doi: 10.1177/0963721415589345

Spear, L.P., & E.I. Varlinskaya. (2005). Adolescence: Alcohol Sensitivity, Tolerance, and Intake. *Recent Developments in Alcoholism, 17*: 143-159.

Steffensmeier, D.J., Allan, E.A., Harer, M.D., & C. Streifel. (1989). Age and the Distribution of Crime. *American Journal of Sociology, 94*(4): 803-831.

Steinberg, L. (2004). Risk Taking in Adolescence: What Changes, and Why? *Annals of the New York Academy of Science, 1021*: 51-58. doi: 10.1196/annals.1308.005

Steinberg, L. (2007). Risk Taking in Adolescence. *Current Directions in Psychological Science, 16*(2): 55-59.

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review, 28*: 78-106. doi: 10.1016/j.dr.2007.08.002

Steinberg, L. (2010). A Dual Systems Model of Adolescent Risk-Taking. *Developmental Psychobiology, 52*: 216-224. doi: 10.1002/dev.20445

Steinberg, L. (2016). Commentary on Special Issue on the Adolescent Brain: Redefining Adolescence. *Neuroscience & Biobehavioral Reviews, 70*: 343-346. doi: 10.1016/j.neubiorev.2016.06.016

Steinberg, L., Albert, D., Cauffman, E., Banich, M., Graham, S., & J. Woolard. (2008). Age Differences in Sensation Seeking and Impulsivity as Indexed by Behavior and Self-Report: Evidence for a Dual Systems Model. *Developmental Psychology, 44*(6): 1764-1778. doi: 10.1037/a0012955

Stevens, M.C. (2016). The contributions of resting state and task-based functional connectivity studies to our understanding of adolescent brain network maturation. *Neuroscience & Biobehavioral Reviews, 70*: 13-32. doi: 10.1016/j.neubiorev.2016.07.027

Tamm, L., Menon, V., & A.L. Reiss. (2002). Maturation of Brain Function Associated With Response Inhibition. *Journal of the American Academy of Child & Adolescent Psychiatry, 41*(10): 1231-1238.

Throntveit, T. (2011). William James's Ethical Republic. *Journal of the History of Ideas, 72*(2): 255-277.

Van Duijvenvoorde, A.C.K., Peters, S., Braams, B.R., & E.A. Crone. (2016). What motivates adolescents? Neural responses to rewards and their influence on adolescents' risk taking, learning, and cognitive control. *Neuroscience & Biobehavioral Reviews, 70*: 135-147. doi: 10.1016/j.neubiorev.2016.06.037

Varlinskaya, E.I., Vetter-O'Hagen, C.S., & L.P. Spear. (2013). Puberty and gonadal hormones: Role in adolescent-typical behavioral alterations. *Hormones & Behavior, 64*: 343-349. doi: 10.1016/j.yhbeh.2012.11.012

Viney, W. (2001). The Radical Empiricism of William James and Philosophy of History. *History of Psychology, 4*(3): 211-227. doi: 10.1037//1093-4510.4.3.211

Wagner, F.D. [Reporter of Decisions]. (2005). Cases Adjudged in The Supreme Court at October Term, 2009. Docket No. 03-633 (Court Opinions). Pgs. 551-630.

Wagner, F.D. [Reporter of Decisions]. (2010). Cases Adjudged in The Supreme Court at October Term, 2009. Docket No. 08-7412 (Court Opinions). Pgs. 48-125.

Waller, G., Scott, O., Lilienfeld, A.T., & D.T. Lykken. (1991). The Tridimensional Personality Questionnaire: Structural Validity and Comparison with the Multidimensional Personality Questionnaire. *Multivariate Behavioral Research, 26*(1): 1-23.

Whiteside, S.P., & D.R. Lynam. (2001). The Five Factor Model and Impulsivity: using a structural model of personality to understand impulsivity. *Personality & Individual Differences, 30*: 669-689.

Wolf, R.C., & Dr. M. Koenigs. (2015). Brain Imaging Research on Violence and Aggression: Pitfalls and Possibilities for Criminal Justice. *Science in the Courtroom,* 1-7.

Zuckerman, M., Eysenck, S., & H.J. Eysenck. (1978). Sensation Seeking in England and America: Cross-cultural, Age, and Sex Comparisons. *Journal of Consulting and Clinical Psychology, 46*(1): 139-149.

# APPENDIX

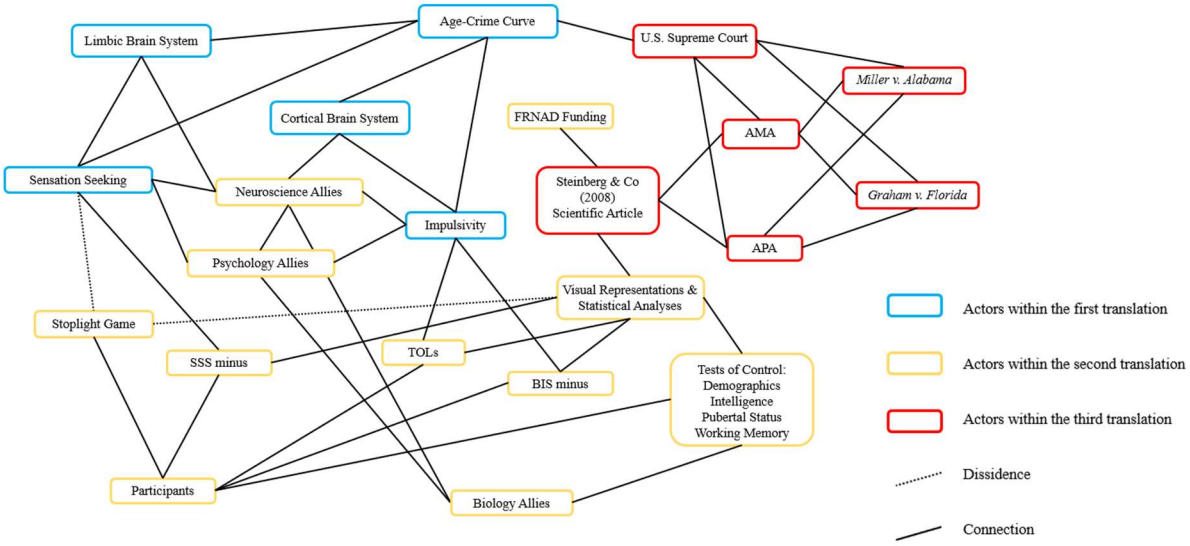


*Figure 1:* Visual Representation of the Adolescent Entity Molecule described in the analysis. [Produced on Microsoft PowerPoint]

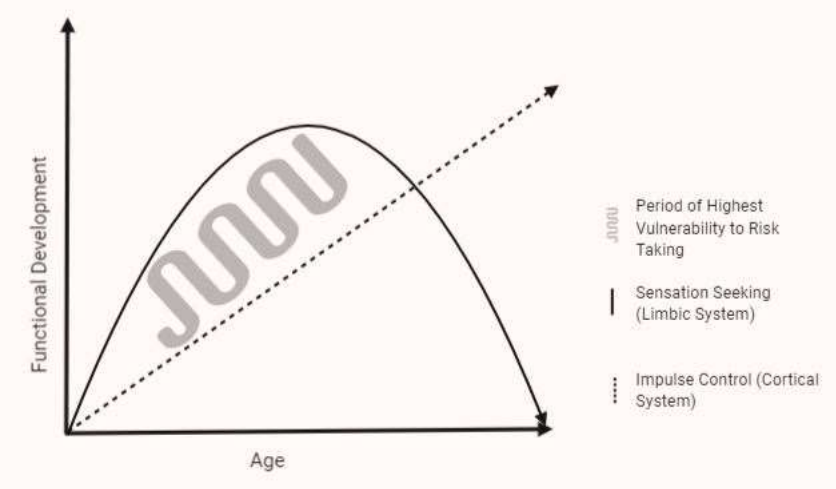


*Figure 2:* Representation of the developmental trajectory of sensation seeking and impulse control in the dual systems model posited by Steinberg and colleagues (2008). [Produced on BioRender.com]

The following three images were copied from the Steinberg and colleagues (2008) text. They are not my work and are presented here for direct access to some figures presented in the work.

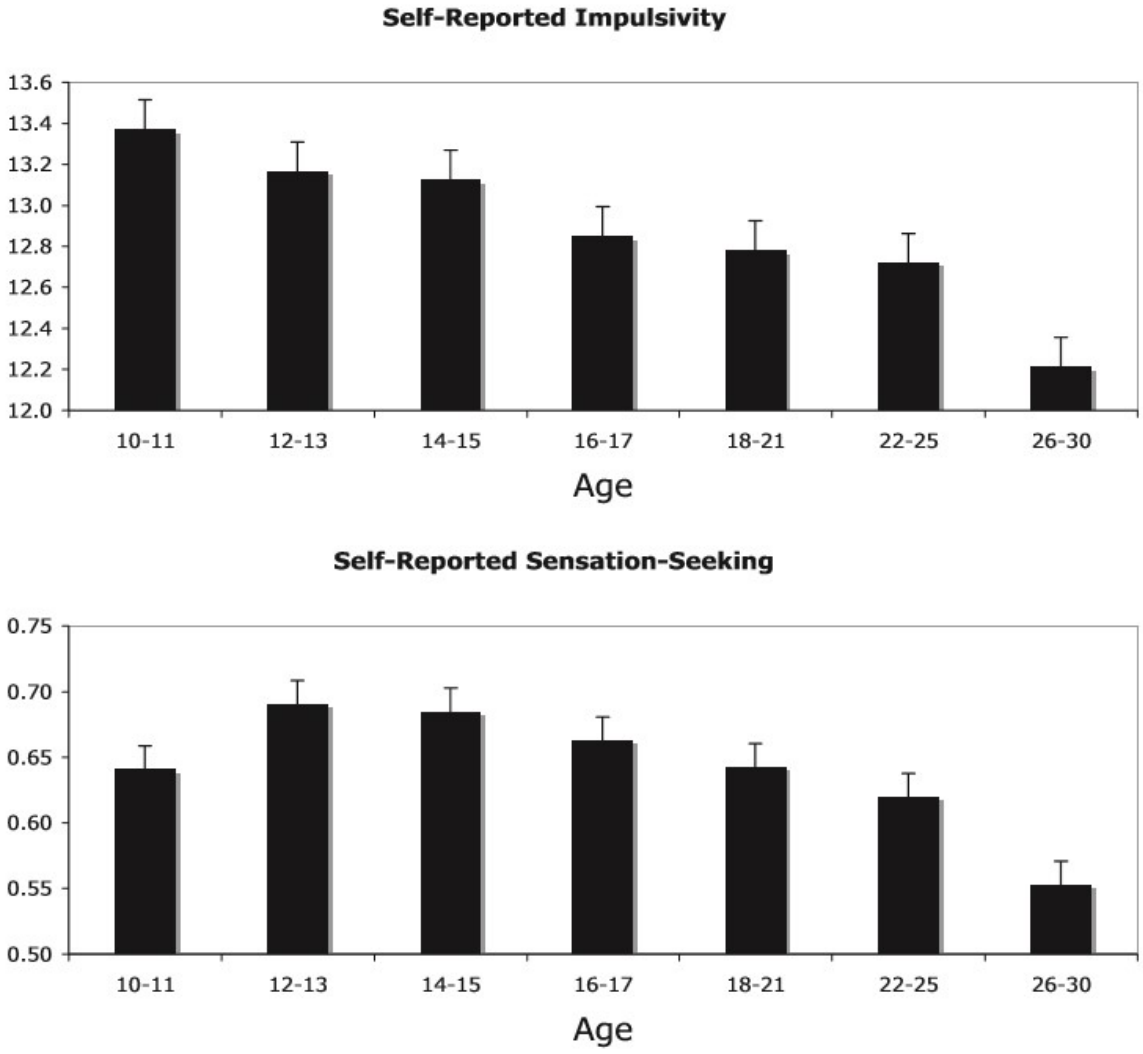


*Figure 1.* Age differences in self-reported impulsivity and sensation seeking. Impulsivity scores can range from 6 to 24. Sensation-seeking scores can range from 0 to 1. The linear trend for impulsivity is significant at $p < .001$; the linear and quadratic trends for sensation seeking are significant at $p < .001$ and $p < .005$, respectively. Error bars represent the standard errors.

*Figure 3:* Visual representation of results from self-report *inscription devices* of impulsivity and sensation seeking. Take from page 1771 of the Steinberg and colleagues (2008) text.

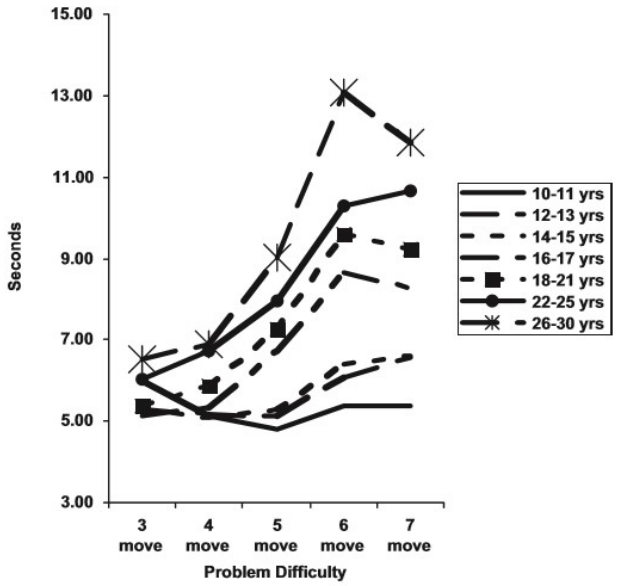


*Figure 3.* Age differences in time to first move (in seconds) on the Tower of London task as a function of problem difficulty. Means are adjusted for IQ and socioeconomic status. The Age × Problem Difficulty interaction is significant at $p < .001$.

*Figure 4:* Visual representation of results from behavioural *inscription device* measuring impulsivity. Taken from page 1773 of the Steinberg and colleagues (2008) text.

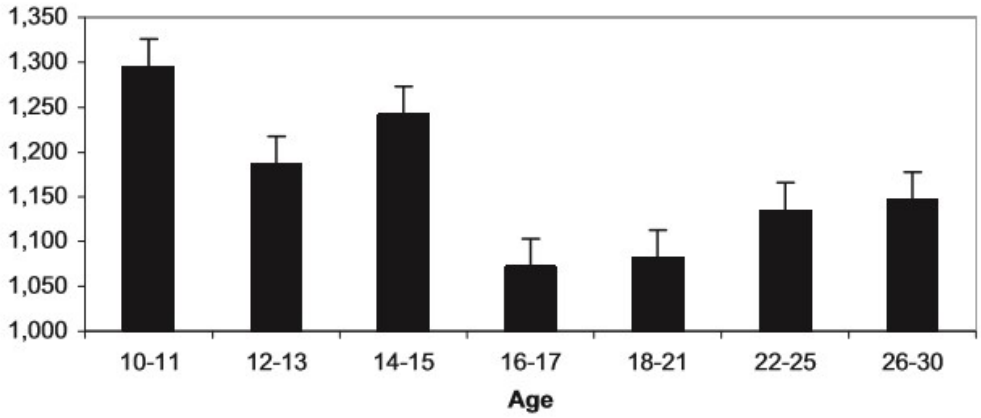


*Figure 5.* Age differences in risky driving in the Stoplight game. Risky driving index is a composite of failure to brake at yellow light and/or long latency to brake after yellow light appears. Means are adjusted for IQ and socioeconomic status. The main effect for age is significant at $p < .01$. Error bars represent the standard errors.

*Figure 5:* Visual representation of results from behavioural *inscription device* measuring sensation seeking. Taken from page 1775 of the Steinberg and colleagues (2008) text.

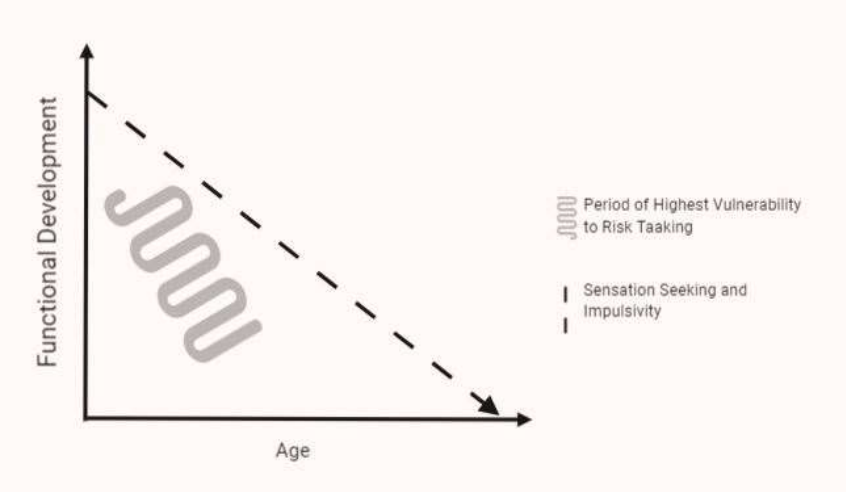


*Figure 6:* Representation of the developmental trajectory of sensation seeking and impulsivity when they are conflated as one behavioural trait. [Produced on BioRender.com]