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Investigation of Intergroup Bias in Two Neuromaturationally Distinct Age Cohorts: An ERP Study

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INVESTIGATION OF INTERGROUP BIAS IN TWO NEUROMATURATIONALLY DISTINCT AGE COHORTS: AN ERP STUDY

BY

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This dissertation is approved as a credible and independent investigation by a candidate for the Doctor of Philosophy in Sociology degree and is acceptable for meeting the dissertation requirements for this degree. Acceptance of this does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

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Currently, sociological investigation of adolescent behavior focuses on the intersection of biography, history, and structure to explain adolescent risk-taking, reward-seeking, impulsivity, novelty-seeking and peer-salience. However, the preponderance of the evidence points away from social ecology and to a significant neuromaturational restructuring event between the 12th and 25th years of life as the root of adolescent behavioral tendencies. As a result, sociological social psychology can benefit from engaging in basic research using neuroscience methods. The present study expands the dual systems model of brain development to account for maturational changes in the social brain network as a way to explain social cognitive differences between adolescents and adults specific to intergroup processing. Central questions driving this research are: why are adolescents disproportionately involved with ultra-tribalistic coalitions and why do they engage in higher rates of coalitional violence than at any other time period in the lifespan? Current social and behavioral evidence suggests that adolescents think about their social worlds very differently than do adults. However, traditional self-report methods and functional magnetic resonance imaging are unable to access early neural responses to intergroup stimuli that are largely unavailable to introspection and require techniques that offer high temporal resolution such as electroencephalography and the event related potential technique. To address these methodological concerns, the present study used notional groups based upon subjects' political orientation and a complex memory and

evaluation task to assess differences in adolescent (18 – 19 yr) and adult (30 – 35 yr) processing of ingroup versus outgroup stimuli on congruent and incongruent trials (5,000 milliseconds [ms]). The 2x2x2x3 design investigated the within-subjects variables of *group* (ingroup & outgroup), *congruency* (congruent & incongruent), and *electrode* (Fz,Cz,Pz) on the P2 and N2 ERP component amplitude. The study had two hypotheses: 1) that an age-mediated activation pattern would be discernable and 2) that N2 amplitude would be higher for adolescent ingroup members versus adult ingroup members due to increased emotional sensitivity to group membership. Neither hypothesis was supported due to statistical constraints arising from group size disparities, however, many interesting additional results were observed. These included different activation patterns predicted by social brain network maturation, as well as, different motivational drivers for adults versus adolescents.

Chapter One: Introduction

> The social neuroscience approach integrates theories and methods of social psychology and neuroscience to address questions about social behavior at multiple levels of analysis. This approach has been especially popular in the domain of intergroup relations, in part because this area of research provides a rich context for connecting basic neurocognitive mechanisms to higher-level interpersonal, group, and societal processes. (Amodio, 2008, p. 1)

The present study explores differences between adolescents and adults at the neurocognitive level of analysis and follows a recent trend within sociological social psychology of incorporating social neuroscience theories and methods (in 2016 the journal *Social Psychology Quarterly* officially requested submissions that used electrophysiology and neuroimaging techniques). Neuroscience research over the past 25 years has revealed a significant neural restructuring event during adolescence that has been shown to predispose members of the epoch to increases in risk-taking, reward-seeking, novelty-seeking, impulsivity, and peer salience—known as adolescent-typical behaviors (Bjork & Pardini, 2015). These findings may offer clues for high rates of gang, hate-group, and religious-fundamentalist memberships among males between 12 and 25 years-of-age. In addition to ultra-tribalistic ingroup memberships, neural maturation may also help explain aggregate data demonstrating an age–crime curve, with higher rates of violent crimes committed during an adolescent "bump." Interestingly the timing of the adolescent bump, especially for violent crime, reflects sexual dimorphism in neural maturation (female brains mature earlier, and the ACC shows an earlier inverted-U that

maps onto the biological timing) (Hirschi & Gottfredson, 1983; Matthews & Minton, 2018).

Adolescent-typical behaviors have also been the subject of criminologists and students of deviance. In recent years Hirschi and Gottferdson's age–crime curve has received renewed interest with the discovery that the inverted-U describing the age–crime relationship holds up in aggregate data both in the U.S. and abroad (Hirschi & Gottfredson, 1983; Matthews & Minton, 2018). Because the age–crime curve maps nicely onto the cognitive and behavioral effects of the inverted-U proposed by the dual systems model of neural maturation, brain development and increased cognitive control may form a foundation for a robust candidate explanation of the inverse relationship between age and crime after the "adolescent peak" (Shulman, Steinberg, & Piquero, 2013).

According to Shulman et al. (2013), in 2011 a hypothesis emerged suggesting that the adolescent peak in crime predicted by the age–crime curve is not at all to do with development but is instead attributable to the fact that on average adolescents are more impoverished than adults or children. Moreover, the authors who proposed the economic hypothesis went further and suggested that the age–crime curve in its entirety is illusory (Shulman et al. 2013). However, using *National Longitudinal Study of Youth* data, Shulman et al were able to control for economic variation and found the predicted age–crime curve with an adolescent "bump" in offending behavior. While a general increase in crime during adolescence is interesting by itself as supporting evidence of a still-maturing prefrontal cortex, the prevalence of violent crime during the adolescent years is of particular interest due to the extreme risk involved and common presence of

accomplices during violent crime—especially those criminal activities that escalated to violence without premeditation. In this light, Farrington's (1986) observation that criminal careers often persist for individual repeat offenders, but the types of crime change with age and specialization is further support for an inverse relationship between cognitive control and risky behavior. Moreover, data presented in Farrington's (1986) seminal work showing sex differences in the timing of the peak of violent and nonviolent crimes (p. 192) supports a modern understanding of earlier neural maturation in females vs. males (Lenroot et al., 2007; Raznahan et al., 2010; Koolschijn & Crone, 2013; Ritchie et al., 2018; Franks, 2018).

Just as criminals may age into other types of less violent crime and age out of coalitional based crime (i.e., crime committed with or for an ingroup), cause of death data show that individuals age out of certain types of death. An underlying cause of death inquiry made on April 30, 2019 via the Centers for Disease Control and Prevention (CDC), National Center for Health Statistics *WONDER online database* for four age groups between 15- and 54-years of age between 1999 and 2017 revealed that Americans between 15–24-years-of-age are more likely to die as a result of homicide than at any other time in the lifespan. Conversely, between 25–34-years-of-age the chance of homicide drops, but the suicide rate increases. However, together homicide and suicide are the two most common causes of death for all persons 15–34 years of age, and death by disease process only begins to move into the top three causes of death after age 35. Accidents are the leading cause of death between 15- and 44-years-of-age, however, further analysis of accident circumstances would be needed to understand those data across the lifespan (see Table 1. for CDC data).

Table 1. Top Five CDC Reported Causes of Death in Four Age Groups (1999 – 2017). Population ≈ 800,000,000.

COD Rank	15 - 24	25 - 34	35 - 44	45 - 54
1	**Accidents** 262,584	**Accidents** 295,152	**Accidents** 317,149	**Malignant Neoplasms** 906,968
2	**Assault (Homicide)** 94,933	**Self-Harm** 109,260	**Malignant Neoplasms** 253,318	**Diseases of the Heart** 687,167
3	**Self-Harm** 87,118	**Assault (Homicide)** 87,087	**Diseases of the Heart** 223,295	**Accidents** 354,469
4	**Malignant Neoplasms** 30,672	**Malignant Neoplasms** 70,261	**Self-Harm** 127,492	**Liver Disease** 151,851
5	**Diseases of the Heart** 19,406	**Diseases of the Heart** 61,970	**HIV** 61,238	**Self-Harm** 144,898
Total	494,713	623,730	982,492	2,245,353
Mean	98,943	124,746	196,498	449,071
Std. Dev.	97367.03	96960.9	101931.8	337701.7

Centers for Disease Control and Prevention, National Center for Health Statistics. Underlying Cause of Death 1999-2017 on CDC WONDER Online Database, released December 2018. Data are from the Multiple Cause of Death Files, 1999-2017, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Accessed at http://wonder.cdc.gov/ucd-icd10.html on Apr 30, 2019 1:08:37 AM

Data like those presented in age–crime curve and cause of death research add to behavioral and biological data that support higher levels of risk and reduced cognitive control. Further, understanding how adolescents engage in intergroup behavior differently than adults requires an understanding of ways in which the adolescent period stands out socially and behaviorally. A combination of rewarding peer approval, increased emotional connection to the ingroup, and willingness to take risks, joined by remodeling that occurs within the social brain network—adolescents think about others differently than adults do—makes adolescent intergroup bias and conflict the most important next-step in adolescence research.

The present study investigates developmentally-rooted, social cognitive differences between adolescents and adults using a social neuroscience approach and electroencephalography (EEG) and event related potential (ERP) techniques while subjects navigate a complex intergroup bias task. Specifically, this study is interested in how adolescent and adult neuro-cognitive responses differ at the group level when viewing members of their own group (the ingroup) vs. members of an ideologically

opposite (politically) group (the outgroup). Additionally, this study explores how the two groups differ when ingroup and outgroup members are paired with congruent or incongruent stereotyped political position statements that require the subject to respond to. Subjects' responses are rapid evaluations (5,000 ms) of the likelihood that the person pictured made or endorses the appended statement. Subjects are required to complete a complex series of cognitive operations that rely on memory and evaluation after becoming familiar with ingroup members but not outgroup members. This set-up mimics real-world social evaluations in that at the individual and group levels more experience is likely with ingroup members than with outgroup members—causing one to see more nuance within the ingroup and more homogeneity across outgroup membership.

Using the dual systems model of brain development as a theoretical framework, the present study demonstrates that adolescents between 18 and 19 years-of-age have different motivational drivers than do adults between 30 and 35 years-of-age when allocating attention to a social stimulus within the first 300 ms following stimulus onset. These motivational differences may offer insight into the disproportionately higher rates of coalitional violence perpetrated by individuals between 12 and 28 years-of-age. Moreover, the results offer insight into potential drivers for more extreme coalitional memberships during adolescence—specifically membership in groups that are tribalistic and provide opportunities for heightened risk and novelty. Despite the study's small sample sizes, the results presented suggest the need for increased investigation of intergroup bias in neuromaturationally-matched cohorts to better understand and explain the robust data available on the topic within sociological social psychology and psychological social psychology.

Briefly, electroencephalography is a recording of oscillatory brain activity generated primarily by dendritic post synaptic potentials (excitatory; EPSPs) in parallel pyramidal neurons that are perpendicular to the scalp surface, and whose synchronous firing results in summated electrical potentials through volume conduction which can in turn be recorded by electrodes at the scalp surface by way of signal transduction and amplification (Nunez & Srinivasan, 2006; Nisar & Yeap, 2015; Cohen, 2017). Neural oscillatory activity has been studied since the late 1920s and through characterization by frequency, amplitude, and phase these "brain waves" (alpha 8–13 Hz [α], theta 4–8 Hz [θ], beta 14–26 Hz [β], delta 0.5–4 Hz [δ], gamma 30–100 Hz [γ], and mu 8–13 Hz [μ]) have been shown to correlate with brain states including cognitive function (Nisar & Yeap, 2015, p. 6 [*paraphrased*]). However, raw EEG contains artifact not related to brain activity (eye-blink, muscle movement, line-noise, etc.) and it is a continuous recording. Therefore, filtering and identifying experimental trials and fixation periods is vital.

The ERP technique allows a researcher to filter, average, and define time-blocks for analysis that contain only the neural responses to a given stimulus. Time blocks (epochs) are defined based on stimulus onset (or subject-response) and a baseline correction period. For example, an epoch may be 400 milliseconds (ms) of fixation, stimulus onset (time-zero), plus 1000 ms of the stimulus presentation; thus, [-400 0 1000]. Epochs can also be "binned," or sorted, based on trial type or subject information for later comparisons. When analyzing ERPs time is measured in milliseconds (ms) along the x-axis and amplitude is measured in microvolts (μV), or one-millionth of a volt (10^{-6}), on the y-axis. ERP components are positive or negative deflections in voltage and classification generally follows the convention of first indicating the direction of the

deflection and then indicating the relative position of the component temporally. For example, the P200 would indicate that the component is positive going and that onset occurs at approximately 200ms. There are exceptions to this convention, however a full discussion is outside the scope of this section and those interested are referred to Luck and Kappenman's (2013) *The Oxford Handbook of Event-Related Potential Components*.

Adolescence, Adulthood, and the Transition Between Childhood and Adulthood

Adulthood is only discernable in comparison to some other period in development—whether that development be physiological or social. While adulthood can be compared to any stage of life, in humans it is most often compared with adolescence, which is the developmental stage that immediately precedes adulthood. As a result of the proximity of adolescence and adulthood (with the former transitioning into the latter) academics in the social, behavioral, and biological sciences have remained interested in achieving a better understanding of the distinct qualities of each epoch including their temporal durations (i.e., onset and offset), as well as, gaining a better understanding of those biological, social, and environmental factors that impinge upon the adolescent during the transition between childhood and adulthood.

Of importance is the boundary between adolescence and adulthood. Onset of adolescence has been accepted as being signaled by onset of puberty. And offset of adulthood is clear and unambiguous—death. Thus, the ambiguity associated with adolescence and adulthood occurs at the inner border. In other words, for how long is one an adolescent and when does one become an adult? The answer to the boundary question is not trivial or merely philosophical. The answer to the boundary question directly affects economic policy, social interventions, criminal and civil legislation punishment,

and how private organizations interact with members of each life-stage (e.g., higher insurance for drivers under 25).

Within social neuroscience, sociological, and psychological research on adolescence, it is customary to define the boundaries of adolescence by using biological onset and social offset. Specifically, onset at the start of puberty (around 10 to 12 years-of-age) and offset when the individual "accepts adult roles" (*see* Foster, Hagan, & Brooks-Gunn, 2008; Sebastian, Burnett, & Blakemore, 2008; Silva, 2012; Hammack & Toolis, 2014; Dannefer & Huang, 2017; Sawyer, Azzopardi, Wickremarathne, & Patton, 2018). Moreover, for practical purposes it is common among U.S. researchers to follow American social convention and place offset, or the acceptance of adult roles and responsibilities, at 18-years-of-age—the age of majority in this country—a convention also adopted by the United Nations to the chagrin of nations for whom this definition does not make sense (Sawyer et al., 2018).

There are three immediately apparent issues with this formulation. First, adolescence is now recognized as being a universal developmental epoch of our species' lifespan. Therefore, it makes little sense using age-of-majority considering the wide variation of ages-of-majority across human societies and cultures. Why should the American age-of-majority be the default and on what scientific merit is a decision like that made? Moreover, how does one compare findings internationally if the age compositions of adolescent groups and adult groups differ. Second, there is an even wider variation across human populations, groups, and individuals for the "acceptance of adult roles." Which roles are adult roles? Do we only use postindustrial conceptualizations of what an adult role looks like, or is even greater variation introduced by relying on each

local presentation of adult roles to define themselves? If a standard is meant, why not use the adult roles accepted by the Hadza or !Kung as the exemplars? Third, the current conceptualization framework for adolescence limits the epoch to "the teenage years." This limitation runs counter to the preponderance of the neuromaturational evidence that demonstrates that brain development during adolescence is exceptionally significant and that it extends into the mid-twenties (Spear, 2011).

Because of the extended neuromaturational period during adolescence those between 18 and 24 years of age are neurologically—and therefore cognitively and behaviorally—like members of the adolescence epoch and not those in the latter half of their third decade of life or beyond. Some have tried to doff–the–cap to this research without doing emotional damage to an "adult" by calling them an adolescent or challenging precedent by creating extensions to adolescence, variously called young adulthood, early adulthood, or emerging adulthood. However, these extensions only add to confusion because of their association with adulthood.

The guiding perspective of the present research is that adolescence is bounded on one side by pubertal onset and one the other by completion of the adolescent neural restructuring event. As stated previously, the significance of the morphological and neurochemical changes that occur in the brain during adolescence cannot be understated. However, understanding or accounting for restructuring in the adolescent brain does not discount or displace explanations for adolescent behavior arising from the social ecology. Additionally, incorporating developmental neuroscience evidence does not diminish the reality of humans constructing and preforming social roles. Adolescence and adulthood clearly have distinct but separate identities socially and biologically. However, social

definitions of adolescence and adulthood appear intimately linked with biology in a bronze-age sense. That is, cultures and culturally appropriate roles have developed in prescientific communities making sense of the world around them. Much of that legacy is reified and maintained in the present age. Roles, especially for ascribed statuses, have a temporal history and a history of place, both are important investigative avenues to understand people accepting the same roles today. However, time and place do not negate maturation or maturational effects on individuals experiencing the life course at the intersection of biography, history, and structure. To discount or ignore biological processes, or to wage war against an early 20th century version of biological science is foolish.

Adolescent neuromaturation at the individual level is subject to individuation through variation in heredity, influences of the proximal social ecology, perturbations to development during earlier epochs, and much more (e.g., access to good nutrition sources, adequate sleep, physical activity, exposure to chronic stress). Above the individual level, and even across some species neural maturation occurs at roughly the same time, for the same duration, and with similar behavioral implications. The neurobehavioral tendencies observed across human cultures and across many social mammals includes increases in risk-taking, reward-seeking, novelty-seeking, impulsivity, and peer salience—collectively known as adolescent typical behaviors. To the uninitiated adolescent typical behaviors sound exceptionally deterministic. To some extent they are, in so much as they will occur and are a product of neural maturation. However, the adolescent typical behaviors are better thought of as tendencies or as a bounding box.

Our phylogenetic history has meant that culture has coevolved with our species and therefore is not simply the lens through which a local population of humans views the environment, but it is also a potent influencing factor for behavior. While a great deal more space is dedicated to the neuroscience literature than the sociological literature, generally the present study follows the consilience approach with a goal of exploring sociological questions at the level of the group using electrophysiology/neuroimaging methods. The general perspective taken is that adolescence is an evolutionarily ancient period of development that is the result of neuromaturational restructuring events (following pubertal hormone triggering) that allow for once adaptive emergent adolescent typical behaviors. This approach does not take the top-down influence of culture, society, or structural constraints lightly though. Think about the adolescent-typical behaviors. What is risky? What is rewarding? What is novel? These questions are answered exclusively by culture and society and history. Class and status affect adolescent-typical behaviors as well. When being impulsive, what access does one have with which to make an impulsive choice? Likewise, one's peers during adolescence are often viewed as a microcosm of their parents' social strata. Certainly, peer salience influences choices made vis-à-vis the other adolescent-typical behaviors. Not meant to be exhaustive, the point is that changes in the brain during adolescence predispose individuals to behavioral tendencies, how the specific behavioral forms manifest is best answered sociologically. That does not, however, mean that knowledge of brain development is unimportant for the sociologist.

Over the course of a lifespan, ontogenetic neuromaturational trajectories interact with environmental stimuli to produce unique synaptic connections that will—by ≈25

years of age (neurotypical)—create dense, fast, and efficient functional neural networks capable of unimaginable feats of computational processing (Andersen, 2003). However, getting from neural-tube to mature PFC is not an easy or guaranteed outcome (Teicher et al., 2003; Taki & Kawashima, 2012). Across species, adolescence is recognized as a life-stage wherein animals transition from a state of dependence to one of independence as a direct result of changes in physiology, cognition, and group dynamics/environmental pressures (Spear, 2011)—largely driven by evolutionarily adaptive "maturational changes in brain structure, function, and neurochemistry" (Gomes et al., 2016, p. 260). These changes push the adolescent away from the natal environment and, more importantly, allow for successful navigation of this transition and its accompanying physical, emotional, and social challenges (Romeo et al., 2016).

By using a social neuroscience approach and methods valuable insights can be gained into neurocognitive processes associated with human social behavior that can supplement that already derived from more traditional methods in sociological social psychology and psychological social psychology (*hereafter referred to collectively as social psychology*). Additionally, in studies of intergroup bias such as the present study a social neuroscience approach is particularly appropriate. According to Amodio "many of the central components of intergroup bias (e.g., the construct of implicit bias) are exceedingly difficult to study using the traditional methods of social psychology, as they appear to be impervious to introspection, and thus to self-report, and are difficult to extract through behavioral measurement" (2008, p. 5). The extremely high temporal resolution of EEG/ERP allows the present research to investigate differences in group

level processing within the first 200 ms after encountering a social stimulus—a period completely outside of human awareness or reflective ability.

Theoretical Model Used

Currently, the best candidate explanation for adolescent-typical behaviors and behavioral and cognitive differences between adolescents and adults on a species level is the dual systems model (DS) (Shulman et al., 2015). Traditionally applied to investigations of adolescent risk-taking, the dual systems model is also able to provide a high degree of explanatory power to investigations of intergroup bias vis-à-vis the social brain network and adolescent restructuring. Briefly, the dual systems model proposes that neural development follows an inverted-U pattern. Among others, areas of the brain involved in top-down control, high degrees of abstraction, and advanced theory of mind are late maturing, with a final pronounced restructuring event taking place between 12 and 25 years-of-age. Because many of the late maturing areas of the brain are implicated in the social brain network the dual systems model is ideal.

Research Methods

This dissertation uses a 2x2x2x3 repeated measures experimental design with one between-subjects variable (age) and three within-subjects variables (group, congruency, electrode). Electroencephalography (EEG) and the event related potential (ERP) technique were used to investigate group-level neurological responses to complex stereotype-congruent or stereotype-incongruent stimuli. Dependent variables were the P2 and N2 ERP component amplitudes. EEG/ERP data were processed in EEGLAB and ERPLAB and statistical analyses were conducted in SPSS.

The relatively noninvasive nature of EEG along with its extremely high temporal sensitivity and ability to access summated, synchronous neural activity in real time has made it a powerful tool in investigations of intergroup processes (Jacques & Rossion 2006; Light et al., 2010; Lopez-Calderon & Luck, 2014; Cohen, 2017). Nowhere more has this been true than with the event related potential (ERP) technique wherein many stimulus- or event-locked trials are averaged and filtered to reveal group-level, target specific neural activity with millisecond precision.

Over the past 30-years ERP methods have been used to investigate explicit and implicit attitudes (Cacioppo, Crites, Berntson, & Coles, 1993; Crites, Cacioppo, Gardner, & Berntson, 1995; Ito & Cacioppo, 2000; Ito, Thompson, & Cacioppo, 2004; Li & Han, 2019), emotional priming (Bartholow, Riordan, Saults, & Lust, 2009; Hill, Starratt, Fernandez, & Tartar, 2019), face perception (Ebner et al., 2010; Liu, Bai, & Pérez-Edgar, 2019), ingroup vs. outgroup face discrimination (Ito & Urland, 2003, 2005; Stahl, Wiese, & Schweinberger, 2008; Walker, Silvert, Hewstone, & Nobre, 2008; Ratner & Amodio, 2013), social categorization (Dickter and Bartholow 2010; Rakić, Steffens, & Wiese, 2018), stereotypes (Bartholow, Dickter, & Sestir, 2006; White, Crites, Taylor, & Corral, 2009), and self-regulation (Amodio, Harmon-Jones, & Devine, 2003).

Moreover, ERP investigations of ingroup vs outgroup social processes continue to add to the already extensive bodies of knowledge on intergroup bias. Here we refer to intergroup bias using the Hewstone, Rubin, and Willis (2002) framework. Hewstone et al. define intergroup bias as: "…the systematic tendency to evaluate one's own membership group (the in-group) or its members more favorably than a nonmembership group (the out-group) or its members. Bias can encompass behavior (discrimination), attitude

(prejudice), and cognition (stereotyping)" (2002, p. 576). As previously stated, the true power of the ERP technique when applied to various aspects of social cognition is in its ability to access human social cognitive processes (with millisecond precision) that are in many cases unavailable to the actor engaging with the task.

Problem

Although ERP components that index ingroup vs. outgroup social cognition are well studied, it is not currently known how component activations vary for intergroup processing when research subjects' age groups are divided along neuromaturationally-distinct boundaries Understanding maturationally-relevant variations in social cognitive processing is an important step toward understanding age-based variations in related data (e.g., statistics for violent-group membership, crime, etc.). At issue is not simply how the distinct developmental groups process social stimuli, but also how members of each group control social information.

Purpose of the Study

Humans are undeniably visual animals (Schoenemann, 2006). As a result, a wealth of data related to neural responses to ingroup vs outgroup members in the visual domain has amassed. Primarily focusing on questions of race (own race vs. other race) and gender (own gender vs. other gender) three primary ERP components have emerged as indexes for social category computations—the N1, P2, and N2 (Ito & Senholzi, 2013). In a 2003 study investigating the automaticity of social categorization, Ito and Urland found that when they showed images of Black faces (outgroup) to White participants N100 (peak 122 ms) amplitudes were higher than for White faces (ingroup). For the same stimuli this trend continued at 180 ms (P2) where amplitudes were larger for outgroup

faces vs. ingroup faces. However, the authors reported a reversal with the N2 (260 ms) with higher amplitudes to White faces than Black faces. Ito and Urland interpreted the P2 component to be an index of early vigilance and the N2 component to be an index of cognitive control. Therefore, these findings indicate that we are more vigilant when encountering an outgroup member than an ingroup member and exert more cognitive control for detailed processing when encountering and ingroup vs. outgroup member—and all within the first 300 ms after seeing an individual. So, the higher the amplitude, the more robust the vigilance or control response (depending of the component).

Ito and Urland's 2003 study resulted in numerous follow-up studies and replications. Of note Dickter & Bartholow (2007) replicated the study with Black and White participants and found that the ingroup vs. outgroup trend was replicated for both Black and White subjects (the original study used White subjects). That is Black subjects showed the same P2/N2 response with Black images as the ingroup and White as the outgroup. Additionally, between 2003 and 2013 multiple replications were conducted across the dimensions of race, gender, and age supporting and adding to the initial findings of Ito and Urland (Mouchetant-Rostaing & Giard, 2003; Ito, Thompson, & Cacioppo, 2004; Ito & Urland, 2005; Correll, Urland, & Ito, 2006; Willadsen-Jensen & Ito, 2006, 2008; Kubota & Ito, 2007; Weise & Schweinberger, 2008; Walker, Silvert, Hewstone, & Nobre, 2008; Wiese, 2012; Dickter & Gyuvorski, 2012;; Ito & Tomelleri, 2013). While the N1, P2, N2, and P3 ERP components all are shown to index important aspects of intergroup processing (Dickter & Bartholow, 2007), the inverse relationship of the P2 (threat detection) and N2 (social cues/inhibition) to ingroup and outgroup stimuli

and the demonstrated reliability of the P2-N2 response make these components ideal for the present novel investigation.

The present study explores the P2/N2 (dependent variables) effect in two age cohorts (18–19-years-of-age [adolescents]; 30–35-years-of-age [adults]) using notional group assignment based upon subject political affiliation. Additionally, non-noxious initiation was used to increase ingroup liking. Following a separate behavioral training session, subjects were asked to view images of ingroup members or novel outgroup (that held an opposing political ideology) members that were paired with congruent or incongruent conservative vs. liberal stereotype statements. Subjects evaluated group affiliation, assessed the statement, and indicated the likelihood that the person pictured made the paired statement. Stimulus timing was 5,000 ms with inter stimulus fixation of 5,000 ms.

Based upon delayed mismatch and the DS model, the present study's "adult" group would have more widely distributed resources available to engage working memory and parse incongruent vs. congruent stimuli. Additionally, increases in myelination coupled with an anterior to posterior shift between adolescence and adulthood in social cognitive processing would suggest that adults would have a more posteriorly oriented activity (vs more frontocentral for adolescents), which also exhibits faster processing of social stimuli as indexed by average peak latency.

Hypotheses

Hypothesis One.

N2 and P2 ERP components will show an age–mediated distribution of maximum amplitude. Adolescents will have more frontally located activation (maximal over Fz), and adults more posteriorly located activation (maximal over Pz).

Hypothesis Two.

Activation patterns will mimic those found by Ito regarding ingroup vs. outgroup—Ito constantly found higher amplitude P2 components when a subject viewed an outgroup member and higher amplitude N2 components when a subject viewed an ingroup member—, but adolescents will be more attentive to ingroup members and will therefore yield higher N2 peak amplitudes when viewing ingroup members compared to the adults N2 peak amplitudes when viewing ingroup members.

Organization of the Dissertation

Chapter one: introduction.

Chapter one includes a brief background concerning the disparity in use of adolescence as a label, as well as, an overview of the theory, methods, problem, and purpose of the present study.

Chapter two: literature review.

Chapter two reviews a brief history of adolescence prior to G.S. Hall and then covers a historical account of sociology of adolescence before reviewing neuromaturational, social brain network, cognitive, and evolutionary explanations for adolescent-typical behaviors. Finally, intergroup bias is considered.

Chapter three: theoretical framework.

Chapter three presents the dual systems model and highlights brain regions and structural and functional connections in the brain that are relevant to adolescent-typical behavior, the social brain, and social cognition.

Chapter four: method.

Chapter four explains the subject recruitment methods, inclusion/exclusion criteria, the behavioral training protocol and experimental protocol. Additionally, technical specifications for apparatus, software, and hardware used are given. The method section follows the format and content requirements standard to electrophysiology and neuroimaging research, however, expanded descriptions are added to many subsections of the method section to make the content more accessible to those without exposure to biology, neuroscience, or experimental methods.

Chapter five: data analysis.

Chapter five provides a detailed description of all analyses preformed on behavioral and experimental data. Additionally, the EEG preprocessing pipeline, ERP processing steps, ERP grand-average steps, and jackknifing steps are provided. Finally, this chapter describes a problem with accurately analyzing the ERP data for the current study based upon statistical theory—a problem referred to here as the *Ulrich–Miller problem.*

Chapter six: results.

Chapter six presents the results for ERP data and some select behavioral data. Results are presented in the form of marginal means, a pillai's trace table, and main effects and two-way interaction ERP traces. The electrode site represented by each ERP

trace is clearly indicated, however, with only one exception only data from electrode Cz is presented. A discussion of why Cz data appears instead of data from all midline electrodes is provided in this chapter.

Chapter seven: discussion.

Chapter seven provides interpretations for each hypothesis, discusses limitations and future directions for the present study. Additionally, a short discussion is provided concerning potential future applications for evolution, biology, neuroscience etc. and their methods within sociology. This discussion is based upon my formal graduate education in neurobiology/neuroendocrinology, five-year active membership in a dedicated neuroscience laboratory, and two-years of independent undergraduate teaching in evolution, behavioral neuroscience, and human development—all concurrent with formal graduate education in sociology.

Chapter Two: Literature Review

> Becoming human is one matter. Becoming French, Mongolian, or African-American is another. Becoming Georges Sand, Ghengis Khan, or Martin Luther King, Jr., is still another. Theories of development should address all of these meanings of the term *development* [emphasis original] and the levels of analysis they imply. It is hard, however, to address all levels of analysis, from species to culture to individual, at the same time in a brief format. (Scarr, 1993, 1333)

As both a sociological work and a work of neuroscience, the present research requires grounding in the literature of multiple disciplines and subject areas to fully understand the adolescent in contrast with the adult in a holistic way. As the opening quote from Scarr (1993) suggests, this is not a small undertaking, and there is no doubt that some relevant literature has been unintentionally left out. For over 2000 years Western philosophers, poets, and playwrights like Socrates, Plato, Aristotle, Shakespeare, and Goethe have considered the qualitative differences between adolescence and adulthood (Arnett, 1999; Dubas, Miller, & Petersen, 2003). During the 19th century, biological-developmental differences between adolescence and adulthood received greater consideration (Peacok, 1851; Scientific American, 1858; Jacobi, 1877), and by 1904 dedicated adolescence research communities emerged. The new, dedicated research (in adolescence) communities continue in 2019 in many academic disciplines: including sociology, psychology, biology, and neuroscience. However, adolescence, or the transition epoch between childhood and adulthood, remains poorly understood due to the polysemic nature of the adolescence label, poor interdisciplinary communication of

theory and findings, and current technological constraints (Sawyer, Azzopardi, Wickremarathne, & Patton, 2018).

When one straddles the social and biological sciences, with conciliatory research in mind, having a sense of the histories of lines of academic inquiry is extremely useful. In the present review a historical approach is taken to better understand the long-standing dispute over the essence of adolescence—that is, is adolescence a developmental stage or a social construct? The adolescence/adolescent label is unpacked through: (a) a brief review of adolescence as a label between 1811 and 1877, (b) a reevaluation of G. Stanley Hall's contribution, and (c) a discussion of classical sociology of adolescence and an overview of modern sociology of adolescence. A case is then made for equally valid but distinct lineages for adolescence as a label in both biology and sociology (label use in psychology depends on specialty, with some more aligned with biology and others with sociology). Following the brief historical review of adolescence and the sociology of adolescence, neurobiological and hormonal changes during adolescence will be considered, as will the social brain network, emergence of cognitive control, and finally intergroup bias. Together, the latter half of the review offers a scaffolded approach to a better understanding of how restructuring events in the adolescent brain can impact regions implicated in social processing and cognitive control, which may explain higher rates of intergroup conflict.

Introduction to Adolescence

Adolescence is defined as a time of physical, sexual, and social maturation, and in humans is the final postnatal stage before adulthood (Bogin & Smith, 2000). It is the time in one's life when greater independence from the natal unit is requested *and* granted.

Adolescents' increased freedom and reliance on friends allows them to explore and accept new social roles and become increasingly more aware of societal structures and obligations while still able to retreat to the natal unit when necessary. In other words, adolescents can "try on" aspects of adulthood while still protected by their most familiar social networks and to some extent the judicial system. However, transition from adolescence to adulthood is not always a smooth one. Thinking of transitions in the U. S. alone, adolescents can find that social–adulthood starts well before the age-of-majority due to myriad social–ecological factors. Additionally, adolescents may find that despite the presence of normative transitioning steps throughout adolescence, structural barriers exist that prevent or hamper successful entry into social–adulthood. Moreover, the beginning of social–adulthood at the age-of-majority does not reflect physiological–adulthood as suggested by neuromaturation.

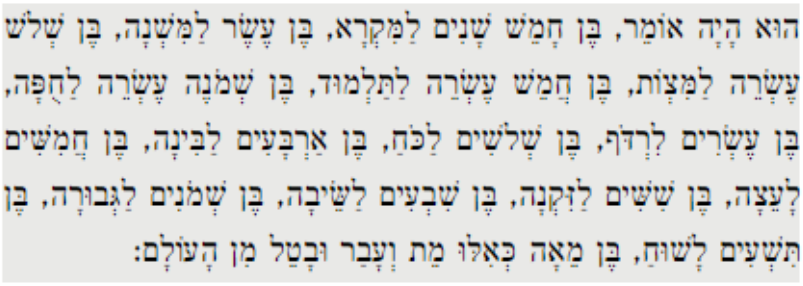
Disparity between the age-of-majority and the completion of neuromaturational events that would render one physiologically mature, or fully adult, is unique among social mammals to humans and reflects cultural adjustments to the unique, protracted postnatal development found in *Homo sapiens sapiens* (Bogin & Smith, 2000; Eccles, Templeton, Barber, & Stone, 2003). The result of developmental differences in humans relative to other social mammals has been an extending of the life cycle with additional developmental stages present in humans that are nonexistent in other species (Bogin & Smith, 2000).

Human societies have recognized the disparity between sexual maturation and neurological maturation in various ways, but primarily through the codification of gradually increasing one's access to full social–adult status after the age-of-majority is

attained. For example, in the U.S. at 18 one may enter into social contracts, join the military, or vote in a political election. However, the 18-year-old is also barred from full participation by election laws that have a minimum age (typically in the 20s or 30s) for holding elected office. Moreover, the 18-year-old is often informally restricted by insurance companies, apartment leasing agencies, and potential employers due to an aggregate increased risk associated with "young adults." While 18-years-of-age is an arbitrary demarcation point for entry into social–adulthood, its use is not uncommon across human cultures and may in part be based upon physical maturation, or the ability to do labor (Kett, 1977).

By way of a broader perspective, Middle Eastern traditions are known to retain ancient rites-of-passage that represent attainment of age-of-majority. One easily identifiable example is that of the Bar Mitzva; occurring at 13-years-of-age, a Jewish boy thereafter holds the title of *ish*, or man, and is considered responsible for his actions (a more modern custom of the Bat Mitzvah occurs for girls at 12). Today this rite-of-passage is largely one of cultural and/or religious significance. However, the written history of social–adulthood at 13 among Hebrew tribes dispersed in the Middle East, but prior to migration into Europe, shows that boys were *technically* obligated to follow religious and civil laws (there was and remains overlap between religious and civil law within Halacha) and were responsible for any infractions. However, in practice a more nuanced view was held—one that is extremely similar to modern conceptualizations of the life-course despite its bronze-age origins. One example comes from a tractate of Pirkei Avot (shown below) that offered guidance for life transitions and roles. Specifically, from 13–18-years-of-age the young man continued with his education, at 18

was married, and only began looking for an independent vocation at the age of 20 (see Figure 1. Pirkei Avot 5:21 below).



כא הוּא הָיָה אוֹמֵר, בֶּן חָמֵשׁ שָׁנִים לַמִּקְרָא, בֶּן עֶשֶׂר לַמִּשְׁנָה, בֶּן שְׁלֹשׁ עֶשְׂרֵה לַמִּצְוֹת, בֶּן חָמֵשׁ עֶשְׂרֵה לַתַּלְמוּד, בֶּן שְׁמֹנֶה עֶשְׂרֵה לַחֻפָּה, בֶּן עֶשְׂרִים לִרְדֹּף, בֶּן שְׁלֹשִׁים לַכֹּחַ, בֶּן אַרְבָּעִים לַבִּינָה, בֶּן חֲמִשִּׁים לָעֵצָה, בֶּן שִׁשִּׁים לַזִּקְנָה, בֶּן שִׁבְעִים לַשֵּׂיבָה, בֶּן שְׁמֹנִים לַגְּבוּרָה, בֶּן תִּשְׁעִים לָשׁוּחַ, בֶּן מֵאָה כְּאִלּוּ מֵת וְעָבַר וּבָטֵל מִן הָעוֹלָם:

Figure 1. Screenshot Image of full text of Pirkei Avot 5:21. https://www.sefaria.org/Pirkei_Avot.5?lang=he; Retrieved 6/24/2019

No doubt many other cases exist like this one, which demonstrates that even in the ancient world there was an understanding that social and biological adulthoods were very different things. Of course, the guidance in Figure 1 was derived from human observational powers and not any specific or meaningful understanding of human physiological development.

Adolescence: A History, Reappraised

The evolutionary history of *Homo sapiens sapiens* (humans) as a social species (Antón, 2003; Hopcroft, 2009; de Castro, Modesto-Mata, & Martinón-Torres, 2015; Willems & van Schaik, 2017; Hershkovitz et al., 2018; Neubauer, Hublin, & Gunz, 2018; Noonan et al., 2018) resulted in an extreme protraction of postnatal physiological development and dependency (Rosenfeld & Nicodemus, 2003). Thus, instead of the three developmental stages (infancy, juvenile, & adulthood) enjoyed by other organisms, in humans we add childhood and adolescence between infancy and adulthood, thereby extending the onset of adulthood well past the start of reproductive ability. As a result, the human life-span is routinely divided into several, physiologically unique

developmental stages; they are: prenatal, neonatal, infancy, childhood, juvenile, puberty, adolescence, prime, and senescence (Bogin & Smith, 2000, p. 521; Rosenfeld & Nicodemus, 2003, p. 74). Adulthood has multiple meanings, all of which are variously applied to humans. Table 2 lists some of the equally applicable definitions of adulthood.

Table 2. Definitions of Adulthood (Onset)

Category	Definition	Citation
Adult Organism	Commences with reproductive maturity	
Biological–Adulthood (Human)	Commences with completion of skeletal growth, homeostasis in physiology, behavior, and cognition	Bogin & Smith (2000), p. 521, Table 11.1
Social–Adulthood (Human)	Acceptance of adult roles (accepting responsibility for one's self, making independent decisions, & financial semi-independence/independence)	Arnett (2001), p. 134

Therefore, the first step in understanding adolescence is to understand which lens adulthood is being viewed through (see Table 2.)

Adolescence as an invention.

Adolescence, as a label, has enjoyed (at minimum) 247-years of use in the English language (see Encyclopædia Britannica, 1771). Across the centuries, use of the label adolescence became increasingly more refined (vis-à-vis the period of the human lifespan onto which it was mapped). Despite refinement, adolescence has never enjoyed a period of static, collective, definitional consensus. The concept of adolescence has always been fluid and remains so in 2019.

The history of *explicit use* of adolescence/adolescent as a label in English-speaking countries prior to the accent of G. S. Hall will be briefly reviewed first. The historical review's importance is its ability to dispel the oft cited tropes that Hall invented the concept of adolescence (Crosnoe & Johnson, 2011) or that adolescence was/is *solely* the invention or by-product of movement from rural farm to urban factory as America

industrialized (Reuter, 1937; Demos & Demos, 1969; Kett, 1977). The danger in simply retyping these easily accepted "background filler materials" is that, aside from being incorrect (Richter, 2006), they can be used to dismiss advances in biological science—particularly in neuroscience. This type of dismissal is not merely a laughable side-effect of siloing, but instead has real-world consequences in the stagnation of scientific progress and current and future influence on social policy and intervention (D'Onofrio & Lahey, 2010).

Although the notion that adolescence was a byproduct of urbanization and education has been around since at least the 1930s (Reuter, 1937), journal articles by Demos and Demos (1969) and Kett (1971) and a book by Kett (1977) helped to revive and popularize the claim.

According to Demos and Demos (1969):

> The idea of adolescence is today one of our most widely held and deeply imbedded assumptions about the process of human development. Indeed most of us treat it not as an idea but as a *fact* (emphasis original). Its impact is clear in countless areas of everyday life—in newspapers, magazines, and books; in various forms of popular entertainment; in styles of dress and of language. Its causes and meanings have been repeatedly analyzed in the work of psychologists and sociologists. Its effects are endlessly discussed by teachers, social workers, officers of the law, and parents everywhere. Yet all of this has a relatively short history. The concept of adolescence, as generally understood and applied, did not exist before the last two decades of the nineteenth century. One could almost call it an invention of that period…. (1969, p. 632)

Historian Joseph Kett (1971) echoes this sentiment but finds that dividing the life-cycle into epochs has much deeper roots—in some cases stretching back to the medieval period. Kett (1971) views the relationship between Western societies and a demarcated transition period between childhood and adulthood on a continuum, in that, some generations found discussions concerning an adolescent period more important than other generations. However, by the time of Rousseau—and primarily because of his treatment of the subject—adolescence became an important period of the life cycle for physicians, scientists, philosophers, and moralists (Kett, 1971). Like Demos and Demos (1969), Kett (1971), draws on anthropology, rural sociology, and historical documents, and following in the intellectual footsteps of Margret Mead, downplays the role of pubertal maturational processes. Instead, Kett looks to society, culture, and economics as the driving forces for the behavioral changes commonly associated with an adolescent period (1971; 1977). Specifically, Kett (1971; 1977) echoes Margret Mead's and Reuter's views that adolescent behavioral problems are primarily linked to urban post-industrial societies wherein labor is not expected of youth and education fills a transition period between childhood and adulthood—a "social bullpen" wherein a young person awaits the availability of adult roles and responsibilities.

One reason for the renewed traction for the claim of an invented adolescence was the amount of historical evidence that appeared to point in that direction (Reuter made the claim without backing it up). However, neither the Demos' or Kett had the internet, and a modern basic search reveals that the foundation claim—that adolescence was an unknown label or concept—quickly breaks down. A *JSTOR* search for *adolescence* provided numerous examples of its use prior to 1880.

From the Demos' (1969) work and Kett's (1971; 1977) works it is clear that the social conceptualizations of appropriate work, leisure, and education for those between 12 and 25 years-of-age changed with urbanization, but the difference between urban and rural areas, both pre- and post-industrialization is a fluid product of that time and place, a snap-shot. In other words, the notion that adolescence was invented *in America* as a result of industrialization and radiated out to the world from *there* and *then* is the height of absurdity, even if one only takes social, structural, and historical variables into account.

First, there are clear examples of protracted transition (adolescence) in nonindustrial societies wherein peer groups collectively define their leisure and work activity and the adolescents provide no appreciable economic support for the adults. For example, cultures that show long-existent adolescent periods are the Hadza and !Kung hunter-gatherers. According to Crittenden (2009) among the Hadza hunter-gatherers of Tanzania childhood is marked by a great deal of play within age-matched peer-groups and as young adolescents age into middle adolescence they engage in solo or peer-group based subsistence and leisure activities that do not support the family or tribal group. While Hadza children have leisure and collect a portion of their substance independently, one may argue that because they are exposed to foraging from the earliest years and begin foraging at five the Hadza children are gradually taking adult roles and are therefore not distinguished from adults in the same way that Western children are. That view would be incorrect, however the !Kung may offer a clearer contrast. The !Kung are a hunter-gatherer people of the western Kalahari and unlike the Hadza, the children and adolescents are not expected to provide any food for themselves until they are married (Hadza youth provide for themselves but not for the group) (Hawkes, O'Connell, &

Jones, 2018). According to Richard Lee (1968) the !Kung adolescents engage in a great deal of leisure activity throughout the day, and spend most of it visiting neighboring villages, which is possible because parents provide the entirety of their diet (as cited in Hawkes et al., 2018, p. 785).

According to Schlegel (1995) "the line between adolescents and youths may be blurred, as when the unmarried young males between 14 and the mid-20s constitute a single, often named, social category with specific duties to the community. Two examples are the *moran,* the warrior grade of the African Maasai and the class of bachelors in preindustrial European villages and towns" (Schlegel, 1995, p. 18). Furthermore, research conducted by Caldwell, Caldwell, Caldwell and Pieris (1998) on historical and contemporary tribal organization among the Ekiti Yoruba of Nigeria support the ubiquitous nature of adolescence across human cultures, despite local variance in adolescent-typical behavioral manifestation. Caldwell et al. report a changing tribal organizational model, moving from a traditional model wherein elder males controlled resources and wives and unmarried men formed the warrior and farmer role groups in the 1890s to a societal model that reduced the number of wives of each elder, made divorce easier, and allowed for earlier marriages for adolescent males (previously marriage occurred between age 30 and 40) (1998). These changes spurred further social change resulting in an adolescence model more familiar to the West, with time set aside for school and career preparation. According to the authors these societal changes were a direct result of British control of the region, as well as, the inflow of Christian missionary groups and entry into the global economy via rubber production and infrastructure-improving labor jobs. Despite these widespread social changes, one cannot say that

adolescence emerged as a latent effect of globalization, only that it became manifest in a more recognizable way. Prior to these changes adolescent males engaged in risky and rewarding behavior and had widespread conflict with their parents (especially their fathers) (Caldwell et al., 1998).

Very simply, the Demos' argument (followed by Kett's) was that adolescence could not exist on farms because all ages of youth capable of work were expected to do their share—children were just little adults. Mowrer, E. R. (1939) and Kett (1971; 1977) also note that socio-economically prior to urban industrialization, the patriarchal structure of the family meant that the father/husband controlled the income of all family members. As a result of the patriarchal structure, adolescents' earned income went to the head-of-house and to room and board costs such that the income of the adolescents' of a household was vital to its financial well-being—if not the income the manual labor on site (Kett, 1977).

However, in the city a distinction emerged. Children were not simply "little-adults" waiting to fulfill their full potential in whatever agrarian role their parents held, and grandparents and great-grandparents held before them. Children in the city: (a) were distinct from adults in the work they did or the way they divided their day; (b) were distinct because they networked with age-group peers instead of adults; (c) and provided little to no economic support to the family unit (Demos & Demos, 1969, pp. 636-637).

So, for Demos and Demos (1969) the origin of adolescence as a life-stage is a byproduct of American urbanization—the move from farm to city and its impact on the family—in the 1800s; whereas, the modern construct of adolescence as it is studied academically owes its existence to G. S. Hall, his child-study movement, and the

publication of *Adolescence*—all occurring between 1880 and 1904. However, the notion that adolescence was an American invention/byproduct of the move from farm to factory during industrialization was not a new claim and was made 30 years prior to Demos and Demos (1969) by E.B. Reuter (1937). Where the Demos' (1969) and Kett (1971; 1977) diverge from earlier usages of the claim is in their use of supporting historical documentation. The supporting documents used separately by Demos and Demos (1969) and Kett (1971; 1977) are not without flaw, however, and create a blinkered view of the concept of adolescence prior to the mid-20th century. One possible reason for the view of Demos and Demos (1969) and Kett (1971; 1977) being accepted so uncritically may have been the long life of the same claim existing in sociological circles without evidentiary support. In other words, because Reuter's claim was made and accepted without evidence, the presence of some evidence in support of the invention of adolescence, no matter how flawed, may have attracted later sociologists simply as a means to gain some footing.

As to the claim that John and Virginia Demos made regarding G. S. Hall as the creator of the modern construct of adolescence, there is little confusion about the genesis of this myth…Hall said it himself. By 1901 G.S. Hall had become extremely passionate about the adolescent life-stage—though his opinions on the nature and needs of the adolescent were not shared by all (Hall 1901). Despite criticisms, Hall was not shy about what he felt were his contributions to the academic world as the leader of the Child Study.

Speaking on the impact of the Child Study movement at Clark University, Hall, then president of the university, modestly states:

> Some four or five years ago, when the critics were loudest and most aggressive, many superficial observers thought the movement dead. But it has steadily spread to department after department. In insanity it has given us the new studies of dementia præcox [early dementia]; has re-created the department of juvenile criminology; furnished a new method of studying the most important problems of philology…;has revolutionized and almost re-created school hygiene; ***made adolescence; a strange word ten years ago, one of the most pregnant and suggestive for both science and education*** [emphasis mine]; given us the basis of a new religious psychology; and laid the foundation of a new and larger philosophy and psychology of the future, based not on the provincial study of a cross-section of the adult mind, but on a broad, genetic basis. The few able psychological and philosophical professors, who still refuse to accept it, as Agassiz did evolution, will not escape the same kind of criticism meted out to him. (Hall, 1903, p. 97)

John and Virginia Demos' heavy reliance on material from the child study movement provide a clue for the origin of the impression that they came away with (Demos & Demos, 1969). However, Hall's (Hall was known as a better spin-artist and promoter than a scientist [Thorndike, 1925]) claim that adolescence was a strange word in 1891 cannot be supported. The first recorded usage of the term in a work dedicated to art, philosophy, and science can be found as an entry in the first edition of the Encyclopædia Britannica:

> Adolescence, the flower of youth, or time of growth in the human species, commencing at infancy, and terminating in manhood. (Encyclopædia Britannica, 1771, p. 27)

While the *Britannica* entry does not seem to match our current usage of adolescence, it provides a clear starting point for knowledge of adolescence as a concept or use of the label to describe a developmental epoch. Adolescence as a label for the period either just after birth or just after weaning until adulthood is reached went in and out of vogue through-out the 1800s and 1900s. However, this usage (as will be shown) began to lose favor in the mid-19th century as human biology and developmental science were becoming more precise. In short, as the scientists of the 19th century learned more the life-span became increasingly subdivided to account for maturational differences. Nevertheless, it is quite possible for a label to fall into obscurity within a 132-year gap (between the above entry and Hall's claim).

To gain a better understanding for the prominence of adolescence as a distinct developmental period in the academic and cultural literature a search for literature referencing "adolescence" between 1780 and 1880 via *JSTOR* was conducted. The literature search reveals a vibrant and explicit use of the term in the U.S., U.K., and France between 1811 and 1880. Additionally, usage of the label appears to have been common enough that it was used metaphorically at least as early as 1811, when author A.P. uses adolescence to refer to America in its youth (p. 435). The label was again used by metaphor in 1852 by Stone, who was making a case against what would eventually become American Sign Language (p. 187). In addition to extended metaphor, adolescence was in regular use during the mid-19th century, however, fluctuation in the

life span applied to the label varies. Despite early fluctuation, the term was in use and appears common.

In 1843 the president of the *Royal Medical and Chirurgical Society*, Alexander Shaw, explicitly uses the label and contrasts that time period with childhood to better understand rickets at different stages in the lifespan. Writing in 1849 on the topic of cerebral apoplexy across the lifespan, Dr. Richard Quain uses adolescence to refer to the period of development "[extending] from a few hours after birth to the age of 20" (p.33). Despite Quain's usage, which is more in line with the 1771 definition, other examples suggest that the boundaries of adolescence were beginning to shift. When describing the conditions of the poor in England, Sykes (1850), contrasts current conditions with the reported conditions from 11 years prior. While those details are not germane, what is relevant is Fripp's (cited by Sykes) description of age-sex sleeping arrangements.

B. Fripp (1839) states:

> In some instances there are 5 to 6 persons in each bed; that there are generally two or three, and frequently without separation of the sexes, or consideration as to age, brother and sister up to adolescence, sleeping commonly in the same room, and not infrequently in the same bed" (cited in Sykes, 1850, p. 47).

Fripp's use of "up to adolescence" is intriguing. There is clearly an element of outrage about the mixed-sex co-sleeping. It is unlikely that Fripp or Sykes would have been terribly concerned with bed sharing at the low end of the Quain usage of adolescence (infancy). It is much more likely that siblings proximal to puberty would appear problematic. However, as their usage of adolescence is not clearly and explicitly defined, we are left with conjecture. Despite the ambiguity of Fripp's usage, and a lack of

clarification from Sykes, the researchers were describing a period in the lifespan, it is probable that the period was close to pubertal onset, and the label was common enough that Sykes did not feel it warranted clarification…in other words, adolescence was a common developmental term.

The argument for adolescence as a common developmental label is further supported by Thomas Peacock, who in 1851 supplemented previous observations that he had made concerning differences in cerebral weight across the lifespan. Peacock (1851) believed that his brain weights clearly demonstrated that the "…the Brain does not attain its full development till from twenty to twenty-five years of age…" (p. 108), which was in direct opposition to the consensus view of the time that "…the brain attained maturity at or before the age of seven" (p. 108). In describing cerebral brain weight at different life stages, Peacock cites his main antagonist, Sir W. Hamilton, and states that the latter established that cerebral maturation concluded at or about age seven by measuring the head of the same individual through three stages—**infancy, adolescence, maturity**. While, Peacock also does not state a clear definition of adolescence it appears to begin sometime around or after age seven and extend until 25 (at the outer-bound).

The range of seven to 25 years-of-age for adolescence was not uncommon in the 1850s or unique to Peacock. By the late 1850s the roughly modern view of adolescence from a life span perspective was becoming more mainstream, that is, there was less variation in its usage (although still some as there is even today) (N. Y. Independent, 1858). The work Flourens, recognized as the pioneer of experimental neuroscience, further refined adolescence by associating onset of adolescence with onset of puberty. An unnamed writer for the Scientific American states:

> In dividing the several periods of man's life, M. Flourens prolongs the duration of infancy up to ten years, because it is from nine to ten that second dentition terminates; ***adolescence up to twenty*** [emphasis mine], because it is at that age the development of the bones ceases; of youth, up to the age of forty, because it is only at that age that the increase of the body in bulk terminates. (Scientific American, 1858, 326)

Thus, not only do we have examples of adolescence being commonly used as a term, we now have a refined period assigned to it that roughly maps onto what we would today call adolescence (e.g., 10–20-years-of-age). While dentition and skeletal development may seem odd as a demarcation signs for developmental stages, they are in fact still used today across species including within human biology for demarcating biological life span epochs (Bogin & Smith, 2000).

Distinctions in the life span appear to have followed the Flourens and Peacock frameworks after 1858, and by 1866 development between birth and twenty had become divided into separate childhood, youth, and adolescence stages (Unnamed Correspondent, 1866). It would be dishonest to suggest, however, that all applications of the label in the mid- through late-nineteenth century were as refined as that given by Flourens and Peacock. The British Medical Journal, describing small-pox related deaths in inoculated individuals, gives a more general timeframe for adolescence as occurring between 6 and 20 years-of-age (British Medical Journal, 1876). Linking the conversation back to G. S. Hall, not only was the term "adolescence" common in the late 1800s (when he was an active researcher), but it was also commonly used in journals of interest to G. Stanley Hall.

It is impossible to have a good sense for Hall's academic reading habits, however, because of his work and interest in education and the issues of coeducation versus segregated-education of the sexes, it is possible that he would have been familiar with the opinions of academics like Mary Putnam Jacobi MD, who in the New England Journal of Education, advocated for coeducation of the sexes up to "…adolescence or the formation of sex…" (1877, 265). Jacobi's fame in the education research community would have made her work visible and in demand. Dr. Jacobi was well known in the field of "school hygiene" and was highly regarded for breaking early barriers by demonstrating that bedrest for women during menstruation was unnecessary with an 1876 article on the topic that won the Harvard Boylston Prize for scientific contribution in the same year (Lincoln, 1877). The focus until this point has been on demonstrating common usage of adolescence in the academic literature, however, there are also examples from the art and literature communities of its explicit usage. Examples from art (Outremer, 1877) and literature (The Crayon, 1856) extend the argument for common usage away from academia and into popular culture. Recall that G. S. Hall claimed that adolescence was a strange word in the 1880s, until he so generously gave it to us.

In the 1877 issue of the journal *Aldine*, Outremer, reviewing the award-winning art of Paris from that year, spends a great deal of space on an etching of the nude plaster sculpture "*L'Adolescence*" by Louis Albert-Lefeuvre, and states: "The lines so harmoniously arranged force one to admit the beauty of this marble child, and sigh to think the days of adolescence are soon gone by" (P. 263). The etching referred to by Outremer is now held at the British Museum and is described thusly: "A sculpture of a naked woman, seen from the front, leaning against a tree trunk in contrapposto, with her

hands raised near her head, looking out at left, with her head slightly tilted; published in the journal 'L'Art', Vol. 6; after Louis Albert-Lefeuvre; proof state. 1876. As noted by the textual description above and in the copy of the engraving below (see Figure 2), adolescence for this artist did not represent childhood, but something closer to our conceptualization of adolescence.

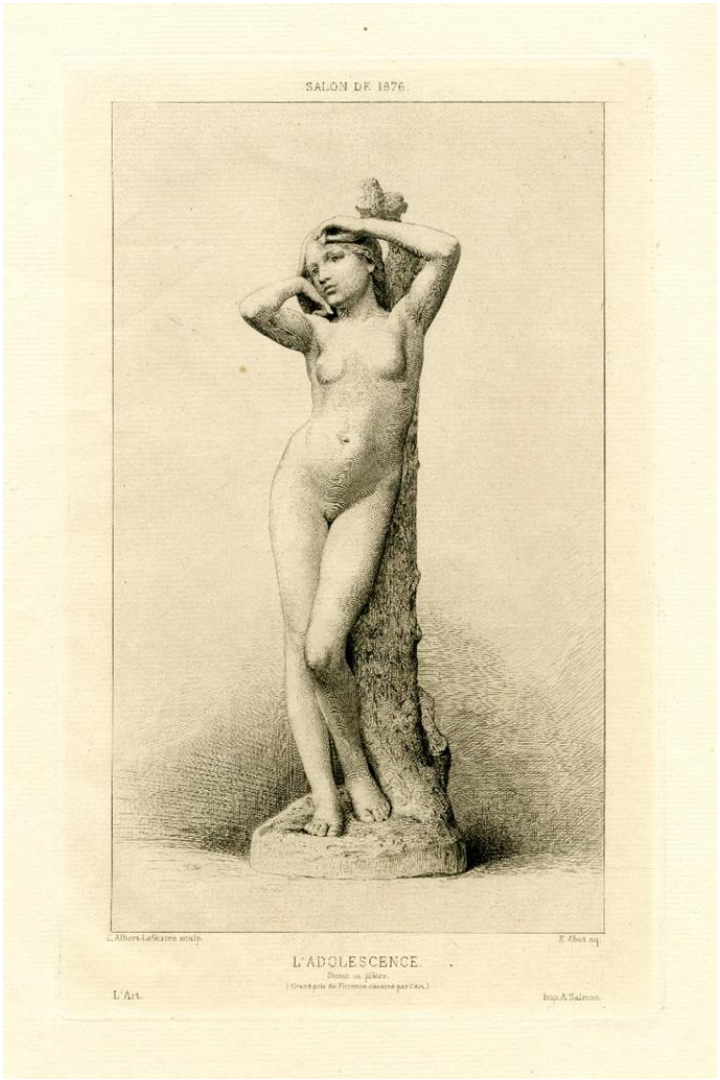


Figure 2. Engraving of "*L'Adolescence*" by Louis Albert-Lefeuvre 1876 as published in L'Art. Currently at the British Museum (London) and housed in the Prints and Drawings collection Museum No. 1877,0210.592. Used with permission.

What then is Hall's true claim to fame vis-à-vis adolescence? Prior to Hall, adolescence was referred to in the scientific literature, but there does not appear to have been any concentrated investigative efforts focused solely on adolescence. Hall's two-volume *Adolescence* deserves credit for sparking interest in adolescence research as a subfield unto itself. Based on the available literature, adolescence–focused research was clearly happening prior to the 1904 publication of *Adolescence* (since at least 1890), but nothing on the order of what followed.

G. S. Hall, the child study movement and dedicated adolescence research.

Understanding the contributions of G. S. Hall is important for all developmental scientists interested in adolescence, whether investigating the life-stage from sociological, psychological, or biological levels of analysis. The popularity, pervasiveness, and longevity of his framework for adolescence directly impacted the formation of a sociology of adolescence (as a reaction) and continues to provide a handy bogyman (representing biological determinism) today (Dornbusch, 1989). In order to move sociological social psychology and the sociology of adolescence—which have been intimately linked since the latter's inception—forward by accepting a conciliatory developmental framework, our baggage must be examined. The best way to do that is to understand what sociologists of the 1930s were reacting to, how that legacy impacts us today, and then critically examine whether the concerns expressed then about the state of scientific knowledge (and its application to human development) are valid at present. It is clear and explicit that the sociologists of the late 1920s and 1930s were reacting to the holes in Hall's work—as will be described below he was simply a very bad scientist,

even by the standards of his day. However, the state of knowledge in every academic discipline has advanced since Reuter's (1937) formal reaction to the Hall-*sian* framework. Nowhere is this truer than in the fields of biology, genetics, and neuroscience.

So, in order to unpack our (sociology's) baggage, we must make some effort to understand Hall's legacy (and receive formal training in biology, evolution, genetics, development, etc.). However, according to Arnett, Hall is often discredited based upon his treatment of masturbation, religious conversion, and a requisite period of "storm and stress" during adolescence (2006). Thus, as it has happened with many of the older social theorists like Comte, Marx, Durkheim, and Spencer, the Hall presented in recent history has been that of a caricature with undue focus on relatively small portions of his work. Very few have engaged with the 1300 pages of *Adolescence,* or any of Hall's other published work, and instead rely on interpretations of it or the recycling of quotes about "storm and stress" (Arnett, 2006). This is a shame considering that we have had 116 years to read the two volumes.

Of course, understanding Hall's flawed theoretical framework is not a call to reincorporate portions of his work as some have advocated (Arnett, 2006) We (the scientific community) have learned a lot about human biology and human ontogeny in the past 116 years—and we have evidence to support our frameworks (Hall liked to invent out of whole-cloth). Understanding G. S. Hall, as he was understood during his lifetime, will show that he did not have universal acceptance, but was a good marketer to the public. Understanding Hall will show that equivocations between his incorporation of evolution and sexual maturation and that of present developmental scientists are

inappropriate. Of course, this takes a foundation-level understanding of the differences between Lamarckian and Darwinian evolution (Hall favored the former), and an understanding of the state of science in 1903 (e.g., pre-DNA consensus, pre-modern synthesis, and without the past 116 years of scientific and technological advancement). Hall was a complicated person and social scientist, and the following reproductions of contemporary accounts of Hall's work from his colleagues (supporters and detractors), along with brief commentaries will hopefully provide a useful tool for reevaluating claims made about Hall and for understanding the continued impact sociology's reaction to Hall has on sociological dogma today.

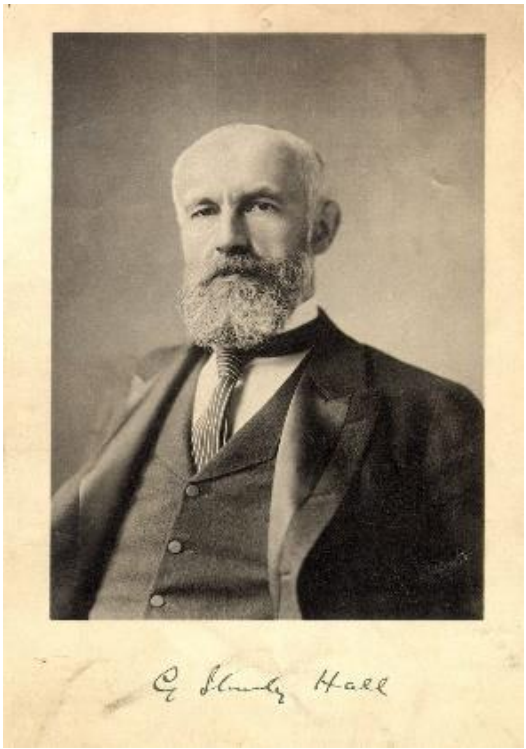


Figure 3. Portrait of G. S. Hall

According to Thorndike (1925):

> Hall was, from his student days to his death, interested in philosophy, psychology, education and religion in every one of their aspects which did not involve detailed experimentation, intricate quantitative treatment of results, or rigor and subtlety of analysis. (pp. 139–140)

There have been countless biographies written about G. S. Hall. The most useful for the present review have been those written by scholars' contemporary to Hall (e.g., Thorndike, 1925; Pruette, 1927), however, the works on Hall produced by Arnett (1999; 2006) and Arnett and Cravens (2006) are also considered. These contemporaneous accounts of Hall's life and contributions to science—written just after his death (1924)—provide a nuanced insight into both positive and negative views of his theories from psychologists and sociologists who lived and researched during the adolescence-as-storm-and-stress fervor. One interesting finding to look out for was that those colleagues closest to Hall had the lowest opinions of his theories and those furthest removed had the highest.

In addition to biographical accounts, the published writings left by Hall offer a great deal of insight into what *he* thought his contributions were to the study of adolescence. When Hall's accounts of his major contribution to adolescence research are taken in context with the previous review of the historical use of the adolescence/ adolescent labels—focusing on common application—and comments by Thorndike (1925), a clear picture emerges of Hall as a great marketer for himself and Clark University where he was President.

The facts that will be laid out are these: Hall did not invent adolescence or make use of the term common; Hall made focused, dedicated research on adolescence "a thing." For that he is owed a debt of gratitude. Prior to Hall, as shown in the previous brief review of how the labels were used in the 1800s, developmental stages were investigated together. In studies of physiology, cognition, or social hygiene, so much was unknown, and so imprecise were the tools, that basic, crude, science was done to elucidate simple differences. Hall, interested in education between 1890 and 1904, plucked adolescence out of the developmental continuum and focused his "microscope lens" on *it alone*—thereby giving researchers permission to do the same. Primarily the legitimacy of studying adolescence independently was created by the child study movement (1890s) and publication of the two-volume *Adolescence: Its psychology and its relations to physiology, anthropology, sociology, sex, crime, religion, and education* in 1904.

To keep the present treatment of Hall focused, only his work on childhood and adolescence is considered. However, it is recognized that Hall's career as a psychologist moved in periods between multiple areas of research interest (see Table 3).

Table 3. Three Periods of Research Emphasis During G. S. Hall's Career

Period	Years	Research Emphasis
1	1880 – 1890	General Psychology and Education
2	1890 – 1905	Concrete Details of Human Life, Particularly the Life of Children and Adolescents
3	1905 – End	Emotional, Ethical, and Religious Life

*Note: Career stages are directly quoted from Thorndike, 1925, p. 140.

As noted in the previous section, Hall truly believed that he created, or at the very least popularized adolescence—a claim not wholly unfounded, but overexaggerated a great deal. In the years directly following Hall's death two extensive write-ups were done on

Hall in the journal *Social Forces* (Odum, 1924; Pruette, 1927). Both articles express the immense impact of Hall's work on social science.

Following an editorial on the contributions of Dr. Hall to social science by sociologist H. W. Odum in *Social Forces* (then *The Journal of Social Forces*) in 1924, Lorinne Pruette (1896 – 1976), an early feminist, psychologist, and student of Hall's, made the case for Hall as a master of social science in the same journal. Preuette's (1927) primary reasons for Hall being distinguished as a master fall into two areas: (1) Hall imported the German methods of "integrating the social sciences through the study of social problems" (p. 549) and (2) Hall was a great promoter of science and science communicator, and as a result caused many people to engage with scientific literature that would not have—specifically his work on adolescence.

As suggested by Pruette, G. Stanley Hall had a career that was not bound by his work on adolescence. By all accounts, Hall was a prolific writer with and equally insatiable thirst for consuming the written word (Thorndike, 1924). Of his 439 publications (see Thorndike for an itemized accounting), Hall wrote philosophical treatises on Hegelian thought, wrote on Mill, published investigations on psychics and ghosts, and of course spent a great deal of time focused on social problems, social hygiene, education, and development (Thorndike, 1924). Additionally, Hall had a productive career investigating a wide variety of social, psychological, and biological phenomena; among them: "genetics, childhood, …, family, education, aberration, and religious phenomena" (Averill, 1990, p. 125). Like sociologists of his day, Hall studied in Germany and felt that psychology was deeply rooted in philosophy (as was the case for sociology). He was however, as Averill put it, "totally committed to the developmental

psychology of the child and the adolescent" (1990, p. 127), until moving on to his final phase of research in 1905 (Thorndike, 1925). However, today, he is best known as the originator of formal adolescence research—though modern conceptualization of Hall and his work is more legend than history (Arnett, 2006; Arnett & Cravens, 2006).

An unvarnished view of Hall is provided in Thorndike's 1924 memoir for Hall published with the National Academy of Science. The memoir is in two discernable parts. The first part of the memoir is a short biography of Hall and a critical analysis of Hall's legacy written by Thorndike. The second part of the memoir is a reproduction of a survey sent to members of the American Psychological Association (APA) asking them to rate Hall on several personal and professional measures. Survey respondents were also asked to write something on the topic of: "what Hall has meant to you personally, in a psychological way, what he has contributed or failed to contribute to the subject, and the relative merits of his various studies" (Thorndike, 1924, p. 142).

Because Thorndike and the 165 APA members' responses reflect direct experiences of Hall, or contemporaneous exposure to his work and influence, the select comments by Thorndike and others provides a great deal of insight. The goal in reproducing these comments is twofold. First, it is important to have a sense for how Hall's work was approached during his lifetime and immediately following his death. The views expressed by contemporaries allow us to imagine how a large multidisciplinary backlash to Hall's concept of adolescence could form while his views continued to survive and transmit from one generation of researchers to the next. Starting with Thorndike's view of the consensus concerning Hall's contribution to psychology it is somewhat surprising that the study of adolescence does not receive mention.

Thorndike states:

> A consensus of present opinion would choose as his most important contributions to psychology, first, his advocacy and illustration and support of the doctrine that the mind, like the body, can be fully understood only when its development in the individual and its history in the animal kingdom are understood; and second, his pioneer work in investigating the concrete details of actual human behavior toward anything and everything, dogs, cats, dolls, sandpiles, thunder, lightning, trees, or what not. He had a large share in teaching psychology to be genetic and to study all of human life. (1924, p. 140)

In other words, Hall's contribution is as an early shaper and promoter of psychology as a discipline, rather than on the merit of any one theory—and especially not what was presented in *Adolescence*. Hall's dogmatic adherence to Lamarckian evolution and an odd psychosocial extension of the discredited Meckel–Serres recapitulation hypothesis (as it was expressed by Haeckel [e.g., ontogeny recapitulates phylogeny]), as well as his use of deductive-theory construction, early acceptance of psychoanalysis (he moved away from it later in life), and seeming disinterest in the daily tedium of the scientific process all appear to have colored the views his contemporaries had of him—and reduced his stature (Thorndike, 1924).

The author goes on to state that:

> Hall was, from his student days to his death, interested in philosophy, psychology, education and religion in every one of their aspects which did not involve detailed experimentation, intricate quantitative treatment of results, or rigor and subtlety of analysis…The healthy truth of [Hall's contributions are] blurred by his insistence

upon an extreme form of the theory that the growth of the mind of the individual recapitulates the mental history of its ancestors, and by his assumption that acquired mental characteristics are inherited. [Hall's contributions are also] marred by an apparently extravagant and illegitimate use of the questionnaire method of collecting facts, which, indeed in the hands of some of Hall's followers, seemed a travesty of science…It is the opinion of the writer [Thorndike] that Hall was essentially a literary man rather than a man of science, and artistic rather than matter-of-fact. He had the passion to be interesting and the passion to convince. He was not content with intellectual victory over facts of nature, but must have an interesting, not to say exciting, result. This result he felt he felt as a message which he must deliver to the world as an audience. It is true that he used his extraordinary intellect and energy to discover facts in which he was so fertile. But he was not content with discovery alone, nor with the approval of a small body of experts whose verdict would decide whether his work was without flaw. Nor did he have the omnivorous appetite for truth-getting all along its course, from the details of improving apparatus or observational technique at the beginning to the mathematical treatment of comparisons and relations at the end, which is characteristic of so many modern workers in science. The truth he sought was preferably important, bearing directly upon great issues, pregnant with possibilities of evolution and revolution. To this literary quality, we may perhaps attribute the fact that his theories rather than his discoveries are quoted, and the further fact that so many of his colleagues in psychology were confident that, in this and that particular, they were right and that he was wrong, though they would

> most heartily admit that his was a far abler mind than theirs. Some of them indeed thought that his great abilities were too often used in the interest of undeserving doctrines, and were amazed and irritated by this. (Thorndike, 1924, pp. 141–142)

Not relying on Thorndike's opinion alone, a sample of the 165 responses to the previously stated questions posed by Drs. Burnham and Starbuck to the APA membership regarding Hall's legacy give additional insight. Interestingly, the authors of the survey decided to create two comparison groups of their respondents: the first from those associated with Clark University (where Hall was president and conducted the bulk of his American research), and the second from those unaffiliated with Clark. Across the board, in valence of comment and numerical rating, those unaffiliated with Clark were much more excited by Hall and his work than were those with direct, daily contact with the man. That is not to say that Hall's contributions were not appreciated.

For example, one comment read:

> Dr. Hall started more lines of new thought and set more persons to thinking psychologically than any other person in all history. Some others have been more methodological, have developed more refined technique, and have been better text-book makers. But no other one has had such vision. The analysts, the measurers, the experimentalists, the psychoanalysts, the applied psychologists, all must pay tribute to him for having opened up new vistas in their respective fields. He is the one really original thinker in psychology in all history. James comes next. Some others I could name who are called great are mere technicians. He is the Edison of psychology.

However, not all were so glowing, for example:

> Hall was an unaccountable genius. I never believed him normal.

Or,

> I was a student at – when 'Adolescence' appeared. I read many chapters, my impression growing all the while that the writer was very fertile and original but exceedingly verbose and lacking in critical discrimination or good judgement as to what should be included or omitted in his compendium. … He seemed to me to be in the intellectual twilight zone between genius and insanity, and those of his own pupils with whom I happened to come in contact in the early days of my psychological experience were, it seemed to me, most of them cracked. Later experience taught me how profound his influence was upon some very brilliant minds; but it is useless to deny that his seminar has had a peculiar attraction for freaks who have done a good deal to make our science ludicrous in the eyes of sensible people generally. (Thorndike, 1924, pp. 145–154)

Despite the ambivalence of Hall's contemporaries, he is today forgotten for his role as a popularizer of science and is primarily remembered for his work on adolescence. Moreover, contemporary reference to Hall is often limited to "storm and stress," and according to Arnett (2006), thus does Hall's two-volume *Adolescence* an injustice. Arnett is clear that there is a lot within the pages of the two volumes to scoff at, but insists that because researchers no longer read Hall and simply cite "storm and stress" (which made up considerably little of the work), they miss out on some potentially illuminating insights. For example, Arnett (2006) mentions that Hall correctly identifies and dedicates space to: (a) depression in adolescence, (b) the age-crime curve, (c) relational aggression, and (d) neuromaturation and adolescent-typical behaviors. There

were of course many things that Hall was way off on as well. Arnett, links some of Hall's misses to the era in which he lived—before discovery of the DNA double helix, the gene, and well before ERP and fMRI technology. However, this type of caveat also calls into question some of his correct observation—particularly the ones that seem the most impressive. Like other scientists and social philosophers contemporary with Hall (e.g., G. H. Mead, Cooley, Dewey, James), it is interesting when one finds a reference to a passage that indicates some foreknowledge of cellular and molecular neurobiology long before the technology was available to obtain the knowledge. However, the fact is that these individuals were guessing, there is no other option. One might try to be generous by arguing that these individuals made observations that were ahead of their time and apart of theory-building efforts. However, there is no evidence for sustained research or progress in the area of neuromaturation prior to the 1990s. Moreover, Hall, Mead and the rest do not say how they come to these conclusions. In the case of Hall, resurrecting his thoughts on neuromaturation and adolescent typical behavior will not yield any insight beyond that which available in a modern neurobiology textbook. So, while Hall deserves a complete and historically accurate accounting of his legacy—especially concerning adolescence—there is no reasonable excuse for bringing up his work outside of a historical context.

From Hall to a New Framework for Adolescence

The American Sociology of the mid through late 1920s—on the eve of a formal sociology-of-adolescence—could just as easily been simply called social psychology. In 1927, Hugh Carter analyzed 259 completed surveys from active sociologists regarding their research activities and interests between ~1922 and ~1927. Carter determined that

sociologists grouped under 18 category headings; the top two were social psychology (17%) and education (12%) respectively.

On the social psychology category:

> Most readers will not be surprised to find a large group of American sociologists interested in social psychology. The preponderance of the psychological approach is overwhelming. Probably a full half of those individuals put under other categories are seriously interested in social psychology, even though they are most naturally grouped under "education," or "race," or "social theory." (pp. 209-210)

Note, that no effort was made by Carter to explicitly state "sociological social psychology." Carter also found that the study of adolescence had become an important area of sociological investigation, with half of those directly involved in social psychology listing adolescence as their primary research focus (1927). However, in 1927 there was no formal articulation of a sociological perspective on adolescence (Reuter, 1937), and much of the research attempts to blend psychology, sociology, and biology.

An example can be found in Cox's "Behavior-adjustments and the junior high school curriculum" (1927). Cox conceives of adolescence as a complex mix of biological and social adjustments, beginning at five or six years-of-age. While Cox does not cite Hall, we can see his influence (interestingly, Cox does not cite any major sociologist or sociological school of thought, or sociological theory). Cox details the observable growth patterns that accompany puberty and asserts that they must be considered "in the light of the increasing sex consciousness, sex interests, and sex suppressions which evolve ***from***

the interactions of the child's nature and the social mores and taboos [emphasis mine]" (1927, p. 37).

The mix of sociological and biological thinking continues:

> The child's social awareness which accompanies the maturation is partly a result and partly a cause of his identification of himself with adulthood. The behavior-adjustments to the social practices and attitudes of the adult world complicate and are complicated by the organic changes that are taking place within the unbelievably complex mechanism—the individual boy or girl. (Cox, 1927, p. 37)

Thus, in this one article, the sociological approach to adolescence had elements of Hall's concern for sex drives, had biology (much of which was wrong or irrelevant), and briefly discussed sociological concepts like mores and using adult (gendered) society as a reference group (the term reference group is not used). Cox's influence, and his biosocial approach to adolescent behavior in the education system was not a minor one. Cox would eventually turn the article into a full-length book by the same title, which in 1929 would gain listing as one of the significant books of the year along with Mead's *Coming of Age in Samoa* (Zorbaugh, 1930).

Zorbaugh summarizes Meads book as: "*Coming of Age in Samoa* is a study of adolescence in a different civilization, and advances the thesis that 'adolescent' behavior is not a correlate of puberty, but is entirely the result of the cultural milieu of the growing individual" (1929, p. 512). Zorbaugh quickly follows this summary up by stating that recent work of his own has also shown that adolescent antisocial/ delinquent behavior is better attributed to community than to biological changes. Though many of Mead's conclusions would be discredited after her death, her work, especially *Coming of Age*,

represents an important touchpoint for the emergence of a recognizable sociology-of-adolescence. Prior to Coming of Age there appears to be a complete lack of evidence to support models of adolescent behavior that relied on culture and socialization processes. Mead provided cultural evidence by recording that among the Samoans transition to adulthood was completed without storm or stress and by contrasting the more liberal view of sexual relations in Samoan society with that of American society. For Samoans sexual urges did not lead to social problems because sexual behavior was not taboo. Because Hall took a universalist approach (his view of adolescence was true for all humans within adolescence), M. Mead's work delivered a devastating blow.

By the mid-1930s sociologists focused on adolescence began questioning the very nature of this time period and came to believe that: 1) adolescence was a socially constructed period of life, 2) that adolescence was not inherently turbulent, and that 3) behavioral changes during the second decade of life are not linked to pubertal maturation (Zorbaugh and Payne 1935, Reuter 1937, Simpson and Simpson 1958). Relying heavily on Margret Mead's 1928 study of adolescence and entry into adulthood in Samoa, researchers of this period began to conceptualize the behavioral manifestations associated with adolescence as the products of a Western civilization that prided itself on individuality and did little to aid its young as they transition into and adolescence and then into independent adulthood (Zorbaugh and Payne 1935; Reuter 1937; Schlegal 1995). Despite the further diminishing of Hall's view on adolescence, sociologists were not united on their approach to adolescence research. Sociological adolescence research in 1929 and throughout much of the early 1930s followed multiple threads, some maintained a Hall–sian view, many drew on G.H. Mead (1967) and Cooley (1902), and

also the influences of Znaniecki and Sumner (Wirth, 1939). Generally speaking, (except for those wooed by the pseudoscience of psychoanalytic theory; e.g, Groves, 1929; Pritchett, 1931) there was an undercurrent of methodological and theoretical integration across social and biological sciences (Ward, 1939; Wirth, 1939).

However, recognition that culture and ecology play an important role in human adolescent development and that cultural and ecological "social facts" could be analyzed and tested in the field and the laboratory gave new life to a sociology concerned with history, structure, culture, and action patterns. As a result, sociological investigations of adolescence began to gain traction by 1935 through the work of sociologists like Hollingworth, Conklin, and Zorbaugh. Sociological efforts—though long in the making—take apart Hall's claim of universal storm and stress through primary investigation in the U.S., but as noted by Zorbaugh and Payne (1935) the work of M. Mead in Samoa and the models and work put forward by Thorndike were influential. Both Mead and Thorndike would play a large, but unnamed role in the argument for a sociology of adolescence made by Reuter (1937). In particular, Mead's findings that in Samoa transition to adulthood was smooth and that cultural definitions, taboos, and how the transitioning adolescents viewed their world all differed—which was counter to the claims made by Hall—made a difference in the sociology of adolescence (Zorbaugh and Payne, 1935). Thorndike, was generally influential as an early and stanch critic of Hall's work on children and adolescence; so much so that his insight that there was a great degree of confirmation bias driving the storm and stress narrative was directly reprinted by Reuter (1937; no doubt it had become the view of many by that time) (Zorbaugh and Payne, 1935).

Because so much of the early sociology covering adolescence is difficult to obtain, we can be grateful to Zorbaugh and Payne for providing the thoughts of Agnes Conklin (also of NYU sociology) on adolescence, which are reproduced below.

On the nature of adolescence:

> What is ‘adolescence’? A complicated matter surely. But when analyzed it turns out to be a measure of how well home and school have prepared the child to meet life. The period is one in which the child is making the transition from dependence upon the family to reliance on self. If he adapts badly, it is all at loose ends, we say he is ‘adolescent’—as if so labeling him explained his difficulties. There are children who have no ‘adolescence’ because they have been prepared for this transition. When the weaning from dependence takes place painfully, the child must be reconditioned for independence. If he is not so reconditioned, he manifests a fumbling form of adaptation, is disturbed and maladjusted in a variety of ways, and is called ‘adolescent.’ (Zourbaugh & Payne [citing Agnes Conklin, no date], 1935, p. 374)

The importance of Conklin’s thought is centered on adolescence as a period of transition that is directly influenced by the family and school structures. Additionally, Conklin views the transition as one of dependence on the family to independence—a view shared by all major disciplines conducting adolescence research. Moreover, Conklin is suggesting that the social relationships shape the transition and the personality of the adult as the individual navigates the adolescent transition period between childhood and adulthood. Therefore, it might be said that Thorndike, Mead, Zorbaugh, Hollingworth & Conklin formed the advanced guard of a sociological adolescence—that is, an

adolescence born of culture and not of biology. Despite early arguments for a socially defined adolescence from within the New York University Sociology Department (i.e., Zorbaugh, Payne, & Conklin), the field observations of Margaret Mead would make the largest initial dent in the Hall–*sian* approach to adolescence.

Margaret Mead's 1928 book *Coming of Age in Samoa* is viewed as the first salvo in the war of nature versus nurture regarding adolescent behavior. *Coming of Age*…, was the result of an ethnographic investigation designed to discover whether adolescence was as universally stormy and sexual as Hall and Freud had each independently claimed. Mead's report that there was no discernable evidence for the universal qualities of adolescence predicted by Hall directly led to the decline of his framework from prominence—though its longevity at the top has resulted some schemas remaining resistant to updating (e.g. the prominence of puberty).

Writing in 1969, Demos and Demos state it well:

> Thus G. Stanley Hall has been largely forgotten, if not rejected outright. Yet, we suggest, he has left his mark all the same. Hall's critics denied the validity of considering personal growth in terms of "stages"; but we still regard adolescence in just such a context. His critics accused him of greatly exaggerating "storm and stress" phenomena, and yet today more than ever we view adolescence in exactly those terms. In fact, the "special cult of adolescence" seems to have lost no strength at all. And it was Hall, more than anyone else, who fixed it in our imagination.

The increased influence of culture can be seen almost immediately in the research of sociologists following the publication of *Coming of Age*. However, that influence is

muddied by the pervasive undercurrent of Hall and Freud. For example, sex and sexuality continued to be concerns for adolescence researchers who divided adolescence into early, middle, and late periods. In 1935 Winifred Richmond published an article in the Journal of Educational Sociology on "sex problems" that began with specific mention of cultural variation using cultures studied by M. Mead as exemplars of variance. Throughout the article Richmond returns to the notion that sex and the intergenerational transmission of sex-knowledge is not universal, but Hall–*sian* undercurrents are apparent in preoccupation with masturbation and homosexuality in boys. Richmond appears to have merged Hall, Freud, and Mead and appears to have determined that in America the transfer of sexual-knowledge (a) occurs in peer groups, (b) is often incorrect and perverse, and (c) that the increased peer salience in adolescence along with transmission of sex-knowledge is responsible for homosexuality for boys but not girls (Richmond, 1935).

On sexual interest development:

> Because early adolescence is the gang and pal age, the stage of development in which the boy's interest is largely centered in those of his own sex, it carries the danger of sexual interest becoming attached to his own instead of to the opposite sex. The number of young boys who are approached by older boys or men with sexual suggestions is much greater than we like to believe. The majority, no doubt, spurn such advances or, if they are led into homosexual practices temporarily, repudiate them later as they learn better or develop more strength of character. But the ranks of the homosexuals are every year recruited from adolescents in the impressionable stage, who fall victim to their own half-

> understood desires and become the easy prey of the unscrupulous. Shutting our eyes to the problem, believing that only boys who are "naturally" degenerate or abnormal can engage in homosexual activities, gets us nowhere in the understanding or intelligent handling of the situation.
>
> These are some of the problems in the sex sphere that engage the attention of the boy in early adolescence. The girl's problems are somewhat different. Because physical aspects of sex are not so constantly in her consciousness, she is likely to turn more to daydreaming and to cherish thoughts and phantasies which are less crudely sexual, but none the less sexual in origin. (Richmond, 1935, pp. 335-336)

Richmond's merger of cultural socialization of sexuality with biological sexual drives and psychosexual development was by no means unique within the sociological literature of the day. Writing in the same year as Richmond, Dimock (1935) conceptualizes sexuality as and achieved status that can only occur through socialization with the opposite sex, especially in late adolescence. This view echoes Richmond's sentiments that if there is a perturbation to this socialization opportunity such that same-sex social groups predominate, heterosexuality cannot be assumed. Dimock and Richmond's works are clear examples of the muddled thinking that can occur when social explanations are thought to provide answers to developmental questions to the exclusion of biological explanations (instead of in concert with them).

In Dimock's words, heterosexual achievement is described thusly:

> Heterosexual experience is present on the childhood level, but the final stage in the completion of boy-girl differentiation should be achieved by late adolescence.

> The word ‘achieved’ is aptly chosen because heterosexual development is not a biological gift, though it should normally receive some impetus from biological changes of puberty. Nor can it take place in a vacuum. It develops only through relationships with the opposite sex. (Dimock, 1935, p. 302)

Classical sociology of adolescence.

It would be all too tempting to claim that M. Mead’s work overshadowed Agnes Conklin’s and Harvey Zorbaugh’s earlier sociological work in the U.S. (Mead’s research having been conducted in Samoa), thereby causing sociology to lose out on being an early leader in the conversation on adolescence. *Coming of Age* was by all measures a best seller, and Mead loomed large as a researcher for many years, however the relationship between sociology and anthropology was very different in 1929 than the one found in 2019. In fact, Mead was a regular contributor to classical sociological formulations of adolescence (see AJS, 1936 & Mead, 1940). In short, sociologists and anthropologists were collaborating eagerly due to complimentary findings that cast doubt on the claim that adolescence was universal, and therefore biological.

In 1936, at the height of the first-wave of the Chicago-school, the editor of the *American Journal of Sociology* (both Ellsworth Faris and Ernest Burgess were editor during 1936; the former outgoing and the latter incoming) published a short editorial on the sociological view of adolescence followed by four separate committee reports—each covering a topic of sociological interest vis-à-vis adolescence (AJS, 1936). Within the editorial section are boundaries for the outer age limits of adolescence, how adolescence should be divided within the boundaries, what the relationship between the social experience of adolescence and physiological maturation during adolescence would be in

sociological research, and finally a broad view of adolescence from a sociological perspective (AJS, 1936). Then, after laying out a basic framework, the editor defines adolescence "sociologically" before yielding space to the committee reports, each of which addresses one area outlined in the behavioral relationships outlined by the editor as suitable for sociological inquiry (AJS, 1936). According to the editor of AJS (1936) adolescence falls (sociologically) between 11 and 20 years-of-age, and can be subdivided into: "*(a)* pre-adolescence, *(b)* adolescence, and *(c)* early youth" (emphases original; p. 81)—however, specific age ranges for each subdivision are not given. The editor then explains the importance of puberty and other developmental processes to adolescence and to sociological and psychological research before beginning an argument for sociological research on adolescence to focus on the "social experience of adolescence" (AJS, 1936, p. 81). In other words, physiological maturation is important generally, and sociologically and psychologically, but the "mental, emotional, and social" (p. 81) aspects of development have nothing to do with biological processes and everything to do with social ecology, roles, and status (AJS, 1936).

Adolescence, for the editor of AJS, is a "state of mind" and terminates "at the point where society expects or demands full adult responsibility" (p. 81). From this perspective, one would answer the introductory question asking whose age-of-majority we should accept as normative by stating that the local presentation is normative only for that population and no others. Additionally, adolescence, from a sociological perspective, is focused on societal status, societal roles, and role conflicts. In fact, the editor directly challenges the contemporary position that adolescent deviance is the result of hormonal shifts secondary to pubertal maturation by providing a purely social explanation. Namely,

that role conflicts were to blame for the behavioral problems experienced with American adolescents. According to the editor, as adolescents develop socially, they will continually attempt to achieve roles that afford them more independence, however, the adults in the lives of independence seeking adolescents provide resistance and offer up roles that maintain dependence on the natal unit and/or social structure (AJS, 1936).

Before summarizing the committee reports (all of which influences Reuter's sociology of adolescence) a final quote will be provided from the editor of AJS. Lengthy as the quote is, within it is the first formal statement concerning sociological research on adolescence. It is also interesting because the quote eludes to personality traits, a popular topic at the time, and begins to separate sociology and psychology (sociological social psychology dominated sociology and, in many ways, the two were indistinguishable in the early 20th century).

The sociological position regarding adolescence in 1936:

> Sociologically, adolescence is a "state of mind," a stage of social development. It represents (I) an intermediate period of detachment of the young person from family control and (2) marked dependence upon his age-group before achieving the degree of individual independence in the making of decisions characteristic of adult status. In this sense many persons physiologically adult never fully outgrow adolescent attitudes and interests. Sociology, perhaps in distinction from other approaches to the study of human behavior, has generally tended to hold the organic conception of the person. Instead of conceiving the person as the sum total of discrete personality traits, it has defined the person as the individual with a status and a rôle in society. The adolescent is to be conceived, then, from the

> standpoint of his status and his rôle in adolescent and adult society. His behavior, therefore, may be studied in the following relationships: (I) the adolescent world; (2) culture and personality; and (3) institutional demands. (AJS, 1936, p. 82)

The committee reports that elaborate upon the above framework are the collective work of many leading figures in the Chicago-school of sociology at the time, as well as, leading cultural anthropologists investigating the human life course. In the reports each committee defines the sociological perspective of the area under consideration (e.g., the adolescent world), outlines what contributions sociologists can make to provide a better understanding on the topics, and then provides some questions to guide future research efforts. In summarizing the committee reports, the future research questions will not be discussed. This is primarily because, while interesting, they do not add to the present discussion, and are quite lengthy. Instead, focus will be on sociological perspectives and contributions. The committee statements will be provided in full, where practical, and commentary added at the end so that the reader can get a full sense for the sociological perspective on adolescence in the mid-1930s. Committee titles are parenthetically followed by the committee members and then immediately followed by the committee's opening statement. Committee contributions are treated in their original order starting with "the adolescent world."

The Adolescent World (E. B. Reuter [chair], H. Blumer, E. Burgess, & E. Frazier):

> The "adolescent world" may be regarded as the world as it is conceived by adolescents. As such, it may be viewed objectively as the interests, activities, values, sentiments, attitudes, and beliefs of adolescents—these being determined, as to empirical content, by aspects of culture that impinge upon adolescents.

> Subjectively, the adolescent world is constituted by a set of definitions or interpretations held by adolescents toward the activities, objects, and institutions of the inclusive social group. The degree of unity and organization and solidarity of the adolescent world will, it is assumed, vary inversely with the ease and uniformity with which the adolescents are able to participate fully in the life-activities and interests of the adult-group. The degree of control exercised by the adolescent world over its members by rules, codes, conventions, and expectations will vary directly with the unity and solidarity of the age-group. (AJS, 1936, pp. 82–83)

The members of the first committee on adolescence begin by further elucidating the sociological position found in the editorial portion of the article, namely that adolescence is socially constructed, actively constructed by local populations of adolescents, and that the social construction of adolescence is in part determined by the distribution of roles and status that eventually leads to the acceptance of adult roles and responsibilities. Thus, adolescence is a conflict between the social construction of adolescence and adulthood from both the perspective of the adolescent and the adult as they collectively negotiate independence, status, and rights.

Culture and Personality (M. Mead (chair); R. Cavan; J. Dollard; & E. Wembridge):

> A study of the adolescent in his "social world" involves questions of personality development and of cultural conditioning. …The sociologist has a definite contribution to make, by defining the social personality of the adolescent girl and boy in given subcultural groups, and also by defining the expected social personality of each sex during adolescence. (AJS, 1936, p. 85)

Members of the second committee go on to state that the sociologist's roles vis-à-vis culture and personality are in providing a better understanding of where the line between cultural variation and biological uniformity exists. The committee suggests research on family dynamics (e.g., parent-child relationships), religious choice, vocational choice, areas where biological urge and cultural mores are in conflict, and "self-assertiveness." To accomplish this research agenda the committee suggests that a combination of "ethnographical field work, case-work, and life-history materials" (AJS, 1936, p. 86). In other words, a surveys and behavioral tests will not do. Instead, to truly understand adolescent culture and personality development, and the division between social drivers in adolescence vs. biological drivers the researchers must spend considerable time in the field. Mead's committee was acutely aware that cultural explanations for adolescent development needed strong empirical support before the wider scientific community (and public) would take notice.

The third committee, focused on institutional demands (R. G. Foster (chair); L. Frank; J. Mallers; F. Shuttleworth; & F. Thrasher), opened its report by stating that every society in every culture "has certain rather definite expectations in regard to the conduct of adolescents" (AJS, 1936, p. 87). This statement may seem in conflict with a previous statement that the sociological and anthropological position was that adolescence was not universal across human cultures and societies. If it were (as we have found it to be today) it would indicate a biological mechanism. However, the position of the AJS committees is not that maturation does not occur or influence the individual during adolescence, but instead that the behaviors attributed to biological maturation are better explained socially. Therefore, from a social development perspective, it would not be untrue to say that

every society and culture has some expectations for its members between 11 and 20 years-of-age, which the AJS editor defines as adolescence—regardless of what a particular culture calls the epoch or how much conflict is expected within it.

The "institutional demands" committee provides a preliminary analysis of eight institutions that it feels warrant sociological attention. Specifically, the committee is interested in "institutional demands, restrictions, and opportunities as the impinge upon the development of adolescents throughout the period of the second decade" (AJS, 1936, p. 87). The eight institutions are: "(1) family and household; (2) economic and business; (3) educational; (4) religious; (5) recreational and leisure time; (6) welfare and correctional; (7) government and legal; and (8) neighborhood or non-institutional demands in the community environment" (AJS, 1936, p. 87). Each area was further subdivided into specific categorical demands and research suggestions were given.

While it may not be presently apparent, the AJS framework for sociological adolescence research, as well as Reuter's formal articulation of a sociology of adolescence that followed one year later, continues to have a major impact on how developmental research is viewed within sociology. Nevertheless, the AJS reports and the work on adolescence done by E.B. Reuter appears to have been forgotten altogether by the time adolescence/youth research revived in sociology in the 1970s.

E. B. Reuter.

> There is almost no literature defining the sociological phenomena of adolescence. There has been practically no scientific research on the sociological level; the sociological reactions of the adolescents to the prevailing culture in which they are immersed are yet to be worked out. (Reuter, 1937, pp. 421–422)

Edward Byron Reuter (22nd president of the ASA; Figure 4) followed up the AJS committee reports (1936) with a formal framework for a sociology of adolescence the next year (1937) with an article titled: *The Sociology of Adolescence*. Reuter, who chaired the "adolescent world" committee for AJS (1936) was, therein, able to fully articulate what he believed the sociological view of adolescence should be.

Figure 4. Portrait of E.B. Reuter. 22nd American Sociological Association President 1935

Reuter starts his treatise by explicitly challenging "storm and stress", "inner turmoil", and "social disorder and misconduct" and "erratic behavior" as normative and universal parts of the adolescent experience (Reuter, 1937, p. 414). Reuter asserts that the overabundance of confirmatory evidence linking maturational changes during adolescence with maladaptive behavior is due more to bias in the data than it is to a true representation of adolescent behavior (Reuter, 1937). Reuter supports his argument by asserting that every society has within it a percentage of antisocial individuals at each developmental stage, and by noting that in 1937 clinicians, members of the legal system,

and academics were biased by the prevailing “storm and stress” view. As a result of the widespread “distorted picture”, Reuter states that a myth of adolescence formed as “later writers copy and embellish statements of their predecessors—repeat errors of observation and inference of the earlier writers” (1937, p. 415). In other words, researchers are seeing what they want to see in their data, having first drunk from the poisoned well. This is not altogether unlike the process that has led to the myth of adolescence as an invention of the industrial revolution—today a claim that is written and embellished without thought or critical examination, and one that began with Reuter himself. According to Reuter (1937), the emergence of adolescence as a distinct transitional period that is fraught with ambiguity, stress, and socially unacceptable behavior can be directly linked with the advent of strict child-labor laws and compulsory public primary and secondary education. In other words, children (in the West) now experienced a significant delay in accepting adult roles, had much more free time, and had innumerable peer-group options as a result of urban social and cultural diversity.

After explaining the folly of “storm and stress” research, Reuter endorses the views of Thorndike; that “adolescence is a period of gradual adjustment to the demands of adult living and that it involves none of the erratic behavior commonly attributed to it” (1937, p. 416). In addition to his proposed framework for the study of adolescence, Reuter set himself to the task of a new concept of adolescence—one that is divorced from biological underpinnings and is instead a social and cultural construct with social and cultural consequences. To this end, Reuter (1937) disputed the emerging biological linkages between puberty and adolescent behavior based upon a cross-cultural analysis of

transitional periods between childhood and adulthood. In doing so, it can be said that Reuter was the first to develop a theory of adolescence as a social construction. According to Reuter:

> [Adolescence] as any other culture complex, it is essentially a system of collective definitions that creates a world apart; it is a body of conceptions in regard to rights and privileges, an indigenous and self-imposed system of standards, conventions, and expectations that influence or determine behavior within the age group." (1937, p. 421)

Reuter's distinctions are important for a modern reader primarily because many of the positions that he advances are subscribed to in the present day—of note is his primacy for a socially-bounded framework for adolescence over maturational explanations for the epoch or behaviors common to it. In other words, understanding Reuter's sociology of adolescence does not shed novel insight onto the life-stage, but instead provides a researcher access into the black-box of the sociology-of-adolescence's lineage of thought—it allows one to examine why adolescence is framed as it is, through a better understanding of its genesis.

Reuter's sociology of adolescence is a call-to-action. His article presents no findings, but it does outline the main divisions between sociological adolescence and other conceptualizations and provide a set of guidelines for moving a sociological research agenda forward. For these reasons, Reuter's framework should be remembered as the genesis of sociological thought on the movement from childhood to adulthood. Reuter's adolescence is one that is interweaved with local cultures (as opposed to humanity in general). The job of the sociologist is to understand how local definitions of

adolescence and adulthood, and the roles each contain, influence group dynamics surrounding and impinging upon adolescence, such that they influence the adolescent's social identity, behavior, and acceptance of adult roles and responsibilities. In other words, Reuter calls for sociologists to "objectify the integration of the social experience" (1937, p. 423). The foundation for Reuter's sociology of adolescence can be summarized in the following way:

1. Adolescence is the period of life when one transitions from childhood dependency to adult social roles and responsibilities and independence.
2. The transitional timing (speed of transition and tempo of role acquisitions prior to full adult role acceptance) will vary from one society or culture to the next.
3. Protracted transitioning—wherein transition to adult roles follows sexual maturation—only occurs in modern, urban, and industrialized societies. In the U.S. the adolescent period is the result of mandatory education and child-labor laws. Preindustrial (Reuter uses the term "primitive") societies and rural societies do not have an adolescent period because children begin learning adult roles early and add to their adult role–repertoire gradually, year-by-year. Additionally, the preindustrial and rural life course, according to Reuter, is such that both children and adults contribute to the economic welfare of the unit (except for children that are totally dependent). In contrast, industrialized adolescents are not able to contribute economically to the family and are able to engage in activities

not associated with their eventual adult roles—leaving Reuter to note that they are in a stage of "tolerable parasitism" (p. 420).

4. Adolescents have created an adolescent world wherein they collectively define the morals and manners that govern behavior during adolescence. This world is closed to adults, but can be accessed for academic investigation through personal documents such as diaries etc.
5. Because adolescence is locally defined by each society and culture and by the adolescents themselves, deviant behavior (and adolescence in general) should be investigated only in its local presentation and not in a larger aggregate. This includes "detailed knowledge in terms of general culture of the group, area, or social class" (p. 423).

In Reuter's own words:

> It is not clear that there is any invariable time relation between the physical and the social phenomena [*here Reuter is discussing physiological maturation including puberty and storm and stress or adolescent conflict*]. The time intervals roughly coincide; both physical adolescence and personality integration fall somewhere between the eighth and the twenty-fifth years of life [*interestingly Reuter's observation maps on to the age span for neural restructuring during adolescence; today this coincidence can be accounted for with the dual systems model of brain development*]. But these statistical statements conceal more than they reveal. In the individual case, the adolescent period is brief; the period of social adjustment may be, and probably is, also typically brief. That both fall within a given ten- or fifteen-year interval does not establish either temporal

> coincidence or sequential relations. The time of one is biologically determined; the time of the other is fixed by definitions of the social group [*Reuter is here laying out the foundation for a socially constructed adolescence, and by extension a socially constructed adulthood*]. The time interval between puberty and adult responsibility may be brief or extended; in individual cases the two may coincide. In modern cultures sexual maturity commonly precedes the time when the group definitions demand responsibility and adult behavior. But in some cases social adjustment on an adult level may coincide with or even precede the period of physical change. (1937, p. 417)

Reuter's position is that variation in the order of obtaining adult roles vs. being sexually mature is evidence that the transition between childhood and adulthood is socially and culturally defined. Reuter provides further support for his argument by referencing "primitive peoples" and comparing rural homogenous societies with modern heterogenous societies (Reuter, 1937). In the case of "primitive peoples," Reuter, who is possibly channeling Mead's findings from Samoa, states that simple societies do not offer diverse and varied activities so children begin taking on small aspects of adult roles at an early age and ever so gradually add to the roles and responsibilities such that by full adulthood the transition is complete and without conflict (Reuter, 1937). Reuter's comparison of rural homogenous vs. urban heterogenous societies is slightly more nuanced.

Incidentally, before Reuter fully articulates his sociology of adolescence, he presages arguments that would be made by Demos and Demos (1969) and Kett (1971; 1977) concerning adolescence as an invention of the industrialized world. So close is

Reuter's claim to the ones made over 30 years later it may be safe to assume that he had some influence—at least indirectly. Of course, pure coincidence is possible as well. Because of the poor citation standards of the past it is only possible to trace intellectual ideas so far.

On adolescence in rural vs. urban-industrialized areas, Reuter states:

> In the more rural areas today, as throughout the whole pioneer era, the period of adolescence appears to be one during which the individual is gradually incorporated into adult society and brought to full and active participation in adult affairs rather than at a time apart. …In the present-day American society there is a lengthened period of preparation for the activities of adult life. This has in practice amounted to a prolongation of social adolescence. The whole expanding educational system—somewhat vague and sentimentalized in character and for the most part not oriented toward the problem of preparation for adult living—has been substituted for and precedes a functionally useful position in the group. The extension and partial enforcement of child-labor laws and the growth of compulsory education have in large measure prevented the transition from being made at or before the physical changes of puberty.
>
> …The changing character of the economic order has operated to the same end. The industrialized urban society has little or no place for the boy in his teens. The traditional social organization made provision for the child in his dependent and early formative years and for the adult and responsible members; the system made no provision for an intermediate group. No intermediate group existed; individuals fell with approximate completeness into two age categories and

> passed directly from one into the other. In the modern world, the lack of any real place or vital function leaves the adolescents in a position of tolerated parasitism. In the absence of opportunity for serviceable activity, youth turns to sport and other forms of restless and disorganized behavior. (1937, pp. 418–420)

Reuter's sociological framework for adolescence has a modern ring to it, and there is evidence that his direct contribution was remembered at least until the early 1950s. In 1951 an empirical study on adolescent–parent socio-economic adjustments lists Reuter first as having contributed to a general sociological theory of adolescence alongside Talcott Parsons, Robert Merton, Kingsley Davis, Robert Dinkel, and Arnold Green (Merton published *Social Structure and Anomie* one year after Reuter's sociology of adolescence and the other authors published between 3–10 years after Reuter's work) (Nye, 1951).

It will come as no surprise to readers with a sociology background that that social deviance became a focal area for adolescence research within sociology, gaining and losing popularity periodically each decade after Merton's *Social Structure* was published. Robert K. Merton, who can be considered the father of social deviance research, was among the group of social researchers in the late 1930s that challenged biological determinism. To that end, Merton (1938) set himself to the study of deviant or nonconformist behavior, and specifically how "social structures *exert a definite pressure* (emphasis original) upon certain persons in society to engage in nonconformist rather than conformist conduct" (p. 672), an approach directly opposed to the popular notion of the day that held that social behavior was the product of either biological impulses or utilitarian rational choices used to suppress those impulses. For Merton, the primary

source of deviant behavior is goal-attainment. More specifically deviant behavior is the result of goal-attainment when the goal becomes so important that the culturally sanctioned means are not seen as binding. Merton states, “fraud, corruption, vice, crime, in short, the entire catalogue of proscribed behavior, becomes increasingly common when the emphasis on the *culturally induced* (emphasis original) success-goal becomes divorced from a coordinated institutional emphasis” (1938, pp. 675–676). Moreover, “it is only when a system of cultural values extols, virtually above all else, certain *common* symbols of success *for the population at large* while its social structure rigorously restricts or completely eliminates access to approved modes of acquiring these symbols of success *for a considerable part of the same population*, that antisocial behavior ensues on a considerable scale” (*all emphases original*; Merton, 1938, p. 680).

Merton’s views about culture, subculture, and the genesis of deviant behavior wer largely in line with those of Reuter, which made it easy for the theory of deviance to fit within the new adolescence framework. From Merton’s initial assumptions about the causes of deviant behavior a robust literature concerning deviance during the adolescent period emerged (Jessor & Jessor 1977; Osgood, Johnson, O’Malley, and Bachman, 1988). The basic thrust of which was that adolescents are subject to the same culturally significant symbols of success as adults, but often lack the means or roles to obtain those success symbols. Therefore, adolescents are more likely to engage in illicit activities to obtain the culturally defined goals.

> To the adolescent peer culture have been ascribed such characteristics as irresponsibility, distaste for constituted authority and established moral codes,

> blind conformity to group values, and a purely hedonistic approach to life. (Simpson & Simpson, 1958, p. 40)

Turning back to Reuter's (1937) framework and legacy, Nye states that Reuter and the other contributors broadly agree that adolescence and adolescent behavior is the result of urban industrialization "which has made the adolescent's labor of little or no value and his maintenance and education a heavy drain on the financial resources of the family" (1951, p. 341). One possible reason Reuter's framework did not become immediately dominant may be his insistence on the illusory nature of adolescent conflict. Reuter was clear in both the AJS committee report (1936) and *The Sociology of Adolescence* (1937) that conflict intrinsic to adolescence is not supported by the statistical data; Davis (1940) counters that the large body of qualitative sociological and anthropological evidence suggesting conflict cannot be dismissed (p. 523). Davis does not argue for a biological view of adolescence—the focus remains on socialization—however, he blames generational differences in knowledge acquisition as the root of conflict (1940). In short both child and parent continue along their social-development trajectories acquiring social knowledge, but the social knowledge acquired by the parent when s/he was at the stage the child/adolescent is presently at the knowledge transmitted was different, thereby leading to conflict. This would lead to a widely accepted conceptualization of the adolescent by Davis (1944) as "period of physical maturity and social immaturity" (Simmons et al., 1973, p. 553).

Following Reuter's theoretical framework, sociologists of education C. Ward Crampton and E. D. Partridge (1938) analyzed a sample of letters submitted to *Boy's Life* magazine. From their analysis, it was concluded that adolescent behavior is primarily

attributable formation of *the self*. Problems associated with adolescence occur because adolescents "[define] themselves according to how others react to them, or how they think they appear to those about them" (Crampton & Partridge, 1938, p. 72). Therefore, "[t]he dynamic aspects of behavior incidental to growing up are not the physical changes themselves but rather the manner in which the relationships surrounding the individual change as his individual growth pattern evolves" (Crampton & Partridge, 1938, p. 66).

Contemporary Sociology of adolescence: 1960 – 2000.

Adolescence research programs of the 1960s were bookended by seminal works by Coleman (1961) on adolescent subculture and, at the latter end, by Demos and Demos (1969) on the social construction of adolescence. Nevertheless, research on the development of *the self*, and how social structure impinged upon that development carried over from the 1940s as a popular line of research through the 1970s. Simmons, Rosenberg, & Rosenberg (1973) were responsible for an early study investigating vulnerability of *the self* during adolescence. Previously, childhood was the time of personality formation and thus development of *the self*, however mounting evidence pointed to adolescence as the crucial period for self-discovery and -definition. Prior to Simmons et al. (1973) it was not known when in adolescence that vulnerability might occur or what candidate causes (Simmons, Blyth, Van Cleave, & Mitsch, 1979) for the vulnerabilities were. The 1973 study by Simmons and colleagues considered psychoanalytic theories of development (i.e., Freud & Erikson), but centered their investigation on a framework derived from the theories of G. H. Mead, C. H. Cooley, and William James. Their framework investigated vulnerability of *the self* along three dimensions: self-consciousness, stability of self, self-esteem, the perceived self (Cooley,

1902; Mead, 1967; Simmons et al., 1973) in a cross-sectional study, which ultimately found that between 12 & 13 “heightened self-consciousness, greater instability of the self-image, slightly lower self-esteem, and a less favorable view of the opinions held of them by significant other” (Simmons et al., 1973, p. 553).

Simmons et al. (1973) tested whether a disturbance in self-image truly occurs during the adolescent period that could explain the “stress and storm” ascribed to the age group by earlier theorists. In a study of 1,917 urban school children in third through twelfth grade the authors did indeed find a change in self-image between school children in elementary vs middle school which continued to some degree throughout the high-school years (Simmons et al., 1973). One area of confusion for the authors emerged in data that showed no difference between 15-year-old respondents that were in middle school versus 15-year-old respondents that were in high school (Simmons et al., 1973). If the behavioral and psychological changes seen in adolescence were purely a consequence of social ecology, age should not have mattered as much as location. However, the lack of difference in reporting between these two populations suggests that both biological and social ecological factors need to be accounted for when considering adolescent behaviors and vulnerabilities.

Having isolated a period of increased vulnerability to *the self* during adolescence, Simmons and a new team of collaborators investigated the impact of the school environment, dating, and puberty on self-esteem in junior high boys and girls (Simmons, Blyth, Van Cleave, & Bush, 1979). Their study attempted to address many of the limitations found within prior studies on with similar research questions by conducting a longitudinal panel study that compared students within a K-8 school and those who

transitioned to a separate junior high school after 6th grade (Simmons et al., 1979). The authors posited that if there were no differences in self-image disturbance between groups (the different schools) the disturbances themselves could be attributed to psycho-biological processes like puberty, but if instead variance was discovered, environmental context would be implicated as the impetus for adolescent changes in stress associated with disturbed self-image (Simmons et al., 1979). Upon completion of the study, their results indicated a lowering of self-esteem regardless of school type, but only girls who went to a junior high school had lower self-esteem that reached the level of significance. Additionally, across the board girls showed lower self-image than boys at 12 years of age. Comparing all groups, the authors found that the most vulnerable population was girls who experienced onset of puberty, school change, and engaged in early dating behavior. Their findings further emphasized the need for intersectional explanations using biology and social ecology by providing evidence for sex-based differences in status and identity linked to the secondary effects of pubertal maturation. That is, changes in body figure and stature affected boys differently than girls. The authors suggested that increased vulnerability for dimensions of *the self* in girls was due to a combined effect of changes in body, differences in school environment, and new social opportunities (dating)—all of which result in ambiguity, uncertainty, and vulnerability as the adolescent girl questions her social standing (Simmons et al., 1979). Despite, clear indications that both social and biological factors were important to the story of adolescence and adolescent vulnerability (in their own data) Simmons et al. (1979) attributed the increase in self-image perturbations after age 12 to entry into middle school and dismissed biological/psychological explanations.

The 1980's ushered in a period of renewed interest in adolescence research. However, unlike the individualistic identity development research of the 1970s, sociology of adolescence took on a biopsychosocial approach. According to Dornbusch (1989), the change to a more inclusive view of adolescence was partly due to increased acceptance of interdisciplinary work in general and partly to do with paradigm shifts within psychology and biology that caused sociological conceptualizations of the social actor recognized and incorporated. By-and-large greater willingness for interdisciplinary collaboration in adolescence research was primarily due to the emergence of Bronfenbrenner's social ecological theory. Other theoretical developments certainly played a role as well. For example, Dornbusch (1989) cites Baumrind's parenting typology, and a series of studies suggesting that adolescence was more crucial than childhood in social development. One common theme that unites the works reviewed by Dornbusch is their primacy of the social experience. Overall the feel of the work is one where biological and psychological inputs are allowed into the models, but nurture dominates nature. For example, Baumrind's parenting typology is reduced to socialization within the family. Social development does not need a biological or psychological explanation, instead it is more important to know whether the parents of a child or adolescent was authoritative, authoritarian, permissive, or neglectful. Despite the breakdown of "traditional barriers between fields" Dornbusch is clear in his statement that "[o]utstanding developmental psychologists now perceive adolescence as occurring in historical, social, organizational, cultural, and institutional contexts" (1989, p. 233).

Another good example of adolescence research in the 1980s is the Udry and Billy (1987) study on coital initiation during adolescence. The authors expressed interest in

initiation of coitus is as an example of a behavior that is firmly rooted in biology, but is constrained within a local culture along age, gender, and racial lines. Because intercourse during adolescence is treated both as a normal part of development and as social deviance, Udry and Billy were able to apply a Bronfrenbrenner-esque model and better understand the strengths of each input: social control, pubertal changes, and peer pressure (1987). Relying on previous data with that collected for their 1987 study, the authors found that androgen levels were positively correlated with a dimension studied influencing sexual behavior in White males and females but not Black females. However, they never state what they mean by androgens; are they discussing free testosterone, gonadal testosterone, … what specifically, and how were the levels measured? No doubt an unfair criticism in 2019.

Deviance was also important to adolescence researchers of the 1980s. Osgood, Johnson, O'Malley, and Bachman (1988: 81; citing Jessor and Jessor 1977: 33) define deviance as "behavior that is socially defined as a problem, a source of concern, or as undesirable by the norms of conventional society and the institutions of adult authority, and its occurrence usually elicits some kind of social control response." From this generalized definition of deviance, Osgood et al. (1988) incorporate the importance of peer-group relations put forward by Akers social learning theory, as well as, the interconnectedness of different deviant behaviors forwarded by Hirschi's social control theory and Gottfredson's theory of criminality. In doing so, the authors propose that "a general tendency toward deviance is sufficient to account for a large group of behaviors and that causes specific to any particular form of deviance are relatively unimportant" (Osgood et al., 1988, p. 82). Their study, which looked longitudinally at white males

between 18 and 22 years of age, found that early marijuana use among 18-,19-, and 20-year-olds was predictive of other illicit drug use later, but the same was not true if onset of marijuana use was at 21 or 22 years of age. Additionally, they found that while a general model of deviance could not explain all deviance variables there was enough generalizability and predictability to continue with a unified model of deviance, wherein deviant behavior would lead to other deviant behaviors—especially during adolescence. Like many other studies, Osgood et al.'s 1988 study provides (in hindsight) additional evidence for links between maturation and deviance.

The 1990s included a revival of the sociology-of-age perspective, specifically as formulated in the essays of Karl Mannheim—in particular his 1923 essay entitled *The Problem of Generations*. According to Pilcher, *Generations* "is regarded as the most systematic and fully developed treatment of generation from a sociological perspective, because it firmly locates generation within socio-historical contexts, and moreover, is part of a wider sociological theory of knowledge" (1994, p. 482). Mannheim's theory of generations looks to "generational location as a key aspect of the existential determination of knowledge. Generational knowledge points to 'certain definite modes of behavior, feeling and thought,' and the formative experiences during the time of youth are highlighted as the key period in which social generations are formed" (Pilcher 1994: 482-3).

During the 1990s there was continued interest in formation of *the self* and the social ecology of the adolescent, including social network composition and conflict centered on the family and the peer-group (Ketterlinus, Lamb, & Nitz, 1991; Galambos & Almeida, 1992; Giordano, 1995; Furstenberg, 2000). It should be noted that Ketterlinus et

al. (1991) are psychologists, but like Bronfenbrenner (1994) are included in the sociology of adolescence of the 90s because of their focus, theoretical frameworks, and methods (Ketterlinus and colleagues provide a review of literature covering developmental and ecological sources of stress for adolescent parents). Additionally, interest in deviance (LaGrange & Silverman, 1999; Furstenberg, 2000) and competence (Clausen, 1991; Finch, Shanahan, Mortimer, & Ryu, 1991; Owens, Mortimer, & Finch, 1996) across the adolescent years gained renewed interest. Along with a burgeoning interest in competence during the transition to adulthood, some sociological social psychologists began focusing on perception of control and how perceived control in adolescence effects the social environment—previously the domain of cognitive psychologists (Finch et al., 1991; Owens et al., 1996).

Using life-span development theory Finch et al. (1991) investigated the effect of mastery, or "the extent to which people see themselves as being in control of the forces that importantly affect their lives" (p. 600), on the work experiences of adolescent boys and girls in the 9th and 10th grades of high school. They found that mastery predicted the type of employment available and was inversely related with stress, indicating a reciprocal forces model wherein the environment shapes the individual and the individual shapes their environment (Finch et al., 1991). The authors expound upon the role of competence in adolescence from a sociological social psychological perspective and assert that a sense of control over life events and outcomes is central to competence, and may include the following concepts: an internal locus of control, self-efficacy, self-determination, perceived competence, competence, self-confidence, and mastery (p. 597). According to Finch et al (1991), perceived or real control over life events leads to a

greater sense of self efficacy, which in-turn effects coping skills (and their employment), persistence, and effort—all of which leads to competence and confidence levels that can predict success in adulthood.

To understand the role of competence vis-à-vis work experience during adolescence, age of work experience, and how these experiences effect adult success Finch et al. engaged in a systematic study of " how the quality of work experience affects the developing control orientations of young workers who are still in high school" (1991, p. 599). To do so the authors investigated (a) the interrelations of adolescent mastery and work experiences (including status, hours of work, and the quality of work experience); (b) the intersection of the individual and the context vis-à-vis gender differences in early work experiences with a focus on informal vs. formal employment; and (c) the impact of adolescents' future plans on work experience effects (Finch et al., 1991).

Their four-year longitudinal study of 1,963 ninth grade students and 1,575 parents found that adolescents tend to select and mold work environments that fit their personalities. According to Finch et al., this finding is supported by life-span development research, which holds "that the individual does not merely submit passively to environmental forces, but actively determines the environmental context" (1991, p. 606). Noting a gender difference, non-employed boys were found to have higher mastery than their working counterparts, whereas there was no observable difference for girls. The authors concluded that work quality is much more important psychologically than work status or work intensity. Additionally, they conclude that, for boys, future plans are directly related to a sense of external mastery, especially for those boys who do not plan to attend university. These boys may see their work experiences as step toward fully

entering their adult roles and meeting cultural expectations that place adult men in work environments external to the home. However, the shifting salience from school to work may have extremely adverse effects on their immediate educational attainment, and in turn on later work opportunities. One caveat is that, for boys, work-type relevance to future goals was very important. In other words, mastery was affected by the perceived relevance of the current work experience to future career or education/career goals. Girls on the other hand were more internally oriented (as opposed to the external orientation found among boys, and especially boys without higher education goals), and did not show a salience to future goals effect. Instead they were motivated primarily by "immediately reinforcing extrinsic job reward – good pay" (Finch et al., 1991, p. 606).

Clausen (1991) studied the role of competence in life success and hypothesized that adolescents who become competent at an earlier stage in adolescence in their chosen roles and identities will have greater success in the transition to adulthood and throughout adulthood. To that end he posited that adolescents from affluent backgrounds that are able to pursue higher education end up having a distinct advantage over others in their age group that are unwilling or unable to gain greater expertise, solidify their identities, and postpone the transition into adulthood through university training (Clausen, 1991). To put it more simply, Clausen (1991) finds a distinct advantage with those adolescents who start out with a plan that will carry them to advantageous positions in adulthood over those who "drift" through adolescence and early adulthood without solid plans and goals.

In addition to the popularity of Bronfenbrenner's social ecological theory and work in social competance, Glen Elder, fully articulated his life course perspective in the 1990s—although he began working towards a life course model in the 1970s (George,

1993; Elder, 1994). George's (1993) review of sociological perspectives on life transitions provides a window into those perspectives that remained or were gaining prominence in the 1990s. Linda George dedicates a significant portion of the review to the life course perspective and states that as a successor to role theory and social stress theory "the emergence of life course sociology during the past two decades provided the most fertile field in which to examine the dynamics, heterogeneity, genesis, and outcomes of life transitions" (1993, p. 369). The allure of the life course perspective during the 1990s appears to be in its formulaic separation from the life span. The life course was/is conceptualized as social phenomena encountered throughout life and "[reflecting] the intersection of social and historical factors with personal biography" (George, 1993, p. 358). Like Mannheim (*The Problem of Generations* [1923]) and Bronfenbrenner, Elder used a chronosystem, however, what makes Elder unique is the intersectionality of his perspective (Bronfenbrenner, 1994; Pilcher, 1994; Elder, 1994). Following the orienting strategy proposed by Mill's in *The Sociological Imagination*, Elder was able to change how sociologists and developmental psychologists thought about the study of human life, and do so in such a way that the perspective could be applied at the macro or micro levels with equally robust explanatory power (Elder, 1994, pp. 4 & 5).

The 1990s also ushered in renewed interest in incorporating the psychology and biology literature with that of sociology. At the outset of the 1990s some researchers engaged with the sociology of adolescence began to take a second look at the biological and psychological literature concerning adolescence and were convinced that the most appropriate explanatory model of adolescent behavior was one that accounted for brain,

biology, genetics, and cultural and social environments—and especially gene X environment interactions (Clausen, 1991). Focusing on the intersection of biology and sociological role learning, Schlegel argues that "adolescence as a social stage is a response to the growth of reproductive capacity," (1995, p. 16) and states that:

> The human life cycle includes a period between childhood and adulthood during which its participants behave and are treated differently than either their seniors or their juniors. A similar social stage has also been observed for sexually mature but unmated males among primates such as baboons and macaques. During this stage, young males are extruded from the company of females and adult males and tend to be spatially and socially placed at the peripheries of these social groupings. In some cases, peer groups of adolescent males have been observed. If a distinctive social stage is present across species, then adolescence is not a product of culture, although many of its features in humans are. The disjuncture between the physical readiness to engage in sexual activity and the social permission to reproduce implies that adolescence is a time of preparation for adult reproductive life. (p. 16)

Despite a renewed interest in the impact of biology on the social environment the focus of sociological adolescence research remained with societal and cultural socialization, group memberships, role sets and role performance, and transitions made from one life stage to the next (Clausen 1991). Moreover, many attempts to incorporate biology and sociology in the 1990s betrayed an immense lack of foundational biological understanding on the part of the sociologists attempting the incorporation. As evidenced in Schlegel's work, various sociobiological concepts are often "cherry-picked" and relied

upon without even a rudimentary understanding of the interaction of all the biological systems—especially the central nervous system—upon behavior. The result is that an inappropriate amount of attention is given to pubertal maturation and reproduction.

Adolescence research in the 21st century was dominated by a continuation of the growing enthusiasm for life course sociology (Crosnoe, 2000; Hagan & Foster, 2001; Harris, Duncan, & Boisjoly, 2002; Chen & Kaplan, 2003; Kok, 2007), and included diverse investigative areas like adolescent friendships, deviance and violence, adolescent risk-taking, early adolescent education and adult socioeconomic status potential, and historical demography. Outside of a life course framework for adolescent transition, deviance, social networks, romantic relationships, violence, and the developing self were popular among researchers—race, class, and gender differences were often coequal to broader transitional concerns (Safron, Schulenberg, & Bachman, 2001; Giordano, 2003; Beutel & Johnson, 2004; Liu & Kaplan, 2004; Johnson, Crosnoe, & Thaden, 2006; Meier & Allen, 2009; Kreager & Haynie, 2011; Haas and Schaefer, 2014; Johnson, Giordano, Longmore, & Manning, 2014; Li and Guo, 2016).

Additionally, there is some evidence of interest in levels of religiosity and other forms of magical thinking during adolescence and young adulthood (Petts, 2009; Desmond, Morgan, & Kikuchi, 2010). Ainsworth's attachment theory was imported to understand family and peer relationships (Giordano, 2003; Nomaguchi, 2008). While many studies included race and gender as variables of interest, use of race and gender composition within a local social ecology was of renewed interest, however because of the era there were more opportunities to examine and compare different racial/ethnic and

gender composition levels than there had been in decades past (for an example see: Lee, 2007).

In 2011 Robert Crosnoe and Monica Kirkpatrick Johnson authored a substantial and influential review of sociology of adolescence research from a life course perspective. While the review contains historical inaccuracies vis-à-vis G.S. Hall and the emergence of adolescence, its breadth and depth of scope are impressive—covering psychological and neuroscience perspectives along with sociological perspectives—considering the orienting strategy. After reviewing past research in life course perspective, the authors state that integrating biological and psychological data is finally allowing sociological evidence to "catch up to developmental theory"—a new branch of life course called the life course tapestry perspective (Crosnoe & Johnson, 2011, p. 449). The purpose of incorporating nature-level data is, according to Crosnoe and Johnson, to "[elucidate] the ways in which genetic traits select adolescents into different relationships…"(2011, p. 449). In the present study, understanding brain responses to social stimuli at different ages can do just that; it can elucidate ways in which adolescents select into different relationships—in this case peer-relationships.

Despite some small mistakes that one might expect of individuals without formal training in an area (e.g. $GABA_AR$ p. 450) the overall message presented is an important one of increased need for sociologists to incorporate biological and psychological (and I would suggest evolutionary) data. However, past attempts at incorporating biological evidence and sociological evidence have failed within sociology. For example, the new life course tapestry approach is little more than a 21st century version of field theory (Lewin, 1939; Wirth, 1939).

Concluding remarks for sociology of adolescence.

Sociological interest in the human life span has as long and vibrant a history as that of psychology or anthropology. In the early 20th century, the study of adolescence was dominated by a framework and narrative established by G. Stanley Hall not only in his two-volume magnum opus *Adolescence*, but his previous work leading the child-study movement as well. Hall's earliest critics—Thorndike, Mead, Conklin, & Zorbaugh—planted enough of a seed-of-doubt about the origins, nature, universality, and reality of Hall's claims that despite the staying power of Hall's perspective two new major articulations of adolescent development were formed; namely the sociology of adolescence and anthropology of adolescence. Anthropology of adolescence did not survive beyond the middle-half of the 20th century in a central or concentrated way because it was not considered a main topic of concern to the field according to Bucholtz (2002). However, following the framework set out by E.B. Reuter (1937), a discernably sociological investigative outlook on youth culture and adolescent transition emerged and has remained a vibrant and central feature of sociological inquiry.

As is apparent in the brief review of sociological considerations of adolescence above, across research generations, levels of analysis, and theoretical paradigms, Reuter primary principle which has been maintained over the decades is that adolescence is social, historical, and local (but certainly not biological). Across the 1990s and into the 2000s sociological theories concerning the life course gained prominence in many areas of sociology outside of adolescence research as well as within psychology subfields concerned with the human life span (see Dubas, Miller, & Petersen, 2003) largely due to inclusive texts like Feldman and Elliot's *At the Threshold* , which presented current

sociological theory and research alongside that of developmental psychologists and historians.

As a result of the popularity of sociological perspectives, psychology, anthropology and developmental neuroscience has integrated structural forces as well as history and biography into their models of human development. However, in the case of life-span development theory the consideration of sociological variables did not lead to an abandonment of ontogenetic or phylogenetic explanations, which has resulted in a more holistic paradigm that considers nature and nurture. Conversely, within sociology, and especially from a life course perspective, dogma and bias have resulted in dismissal and misrepresentation of the biological and evolutionary impacts on human development to such a degree that the one-time goal of merging life course and life span frameworks now seems implausible (Mayer, 2003). That is not to suggest that it isn't periodically argued for still. For example, Gilleard & Higgs (2016) inexplicably use the psychosocial developmental theory of Erikson to attempt a merger. These authors are not alone in their use of Erikson, within sociology of adolescence literature Hall's antiquated and unsupported/unfounded theories of development are regularly mocked or dismissed, but for some reason the equally unfounded and unsupported psychoanalytic theories of Freud and Erikson remain popular with sociologists.

Some social psychologists and sociologists from across subfields (e.g., not just concerned with development) have responded to the increasingly mounting evidence that a sociology that focuses only on social ecology, structural forces, and limited history will quickly become obsolete as researchers from other disciplines willing to consider all levels of analysis offer better explanatory models for human social behavior. For

example, sociologists Booth, Granger, Mazur, and Kivlighan (2006), investigated the links between testosterone and social behavior and suggest that because social status is fundamental to human social groups incorporating non-invasive biological testing (e.g., saliva testosterone, cortisol, etc.) can provide links between biology, behavior, and culture.

McFarland, Moody, Diehl, Smith, & Thomas (2014) demonstrate how behavioral ecology perspectives and an evolutionary psychology outlook can be applied to network ecology analysis in adolescence research. Competing with the life course perspective, role theory, attachment theory, etc. while incorporating the current neuroscience is the life-span wisdom model. Romer, Reyna, & Satterthwaite, (2017) recognize the general increase in risk taking between childhood and adolescence prior to a decline in adulthood but suggest current research models within the neuroscience community may be overstating the case for the numbers of adolescents that engage in maladaptive risk-taking. As a point of interest, this was the same argument made by Reuter when he created the sociology of adolescence, although for him the psychologists, judges, and physicians were overstating the case (Reuter, 1937). The authors separate risk-taking (unambiguous environment), sensation seeking (ambiguous environment) and phenotypic impulsivity (individual finds it difficult to delay gratification) and forward a *life-span wisdom model* (LsWM). The LsWM states that adolescent neural maturation allows for sensation seeking which then leads to exploration of the environment and may reflect an adaptive need to rapidly learn about one's environment—something that comports with adolescent emigrations from the natal unit. The LsWM is certainly compelling but is yet untested and may turn out to be more a model built upon the issue-framing (adaptive-

sensation seeking vs. maladaptive risk-taking) than anything particularly substantive. Certainly, insofar as neural maturation concerns intergroup bias, the LsWM provides additional lenses, but nothing new vis-à-vis the neurobiology.

Adolescent Brain Maturation, The Social Brain, and Cognitive Control

Adolescence is both a social transitional time and one of significant maturational changes, particularly to the brain. Some approaches to the study of adolescence insist on models that emphasize the social ecology, structural forces, and historical factors that influence culture and thus behaving adolescents within a culture. However, humans, as social primates, cannot be divorced from phylogenetic and ontogenetic processes that shape, bound, and allow for human cognition and behavior (Mayer, 2002). If one sampled the academic literature concerned with adolescence over the past 90 years what one would find is that regardless of discipline or theoretical perspective the majority focus is on adolescent cognition and behavior. Even those macro-level studies that are interested in structural constraints or pressures are only interested in them insofar as they affect the behaving adolescent. Additionally, historical accounts of adolescence are ultimately interested in how social, cultural, and economic factors have resulted in changes to adolescent behavior in local populations or collectively.

Because behavior is emergent from cognition and cognition from neural mechanisms that have a developmental trajectory and an evolutionary history, evolutionary history and any significant species-specific developmental changes in the brain are of interest to all researchers of adolescence. Furthermore, changes to brain structure and function across adolescence also results in a period of social vulnerability wherein once adaptive behaviors can, in the modern Western context, be coopted for

more extreme forms of intergroup conflict. For example, increased peer salience can be used to draw adolescents into ultra-tribalistic groups (gangs, hate groups, religious fundamentalist groups), where peer-enhanced predispositions to increased risk-taking and reward-seeking, along with impulsivity characteristic of the developmental stage, can result in more extreme forms of intergroup conflict and coalitional deviant behavior.

Ontogenetic restructuring of the human brain during adolescence can be summarized as a period of regionally specific grey matter pruning events, along with increases in axonal white matter and changes to excitatory and inhibitory neurotransmitter systems (Spear, 2000, Spear, 2011). Grey matter (GM) includes neuronal cell bodies, dendrites, axon terminals, unmyelinated axons, glia, and vasculature (Taki & Kawashima, 2012). Synaptic processes, where electrochemical signaling occurs, are located within the GM, therefore GM pruning events includes a reduction of synaptic connections. White matter (WM) is a fatty substance that (in the CNS) is provided by oligodendrocyte projections and acts like the insulation around electrical wiring in that myelin allows for rapid propagation of the action potential. Grey matter maturation follows an inverted-U (∩) pattern where the ∩ represents gradual increases in cortical and subcortical GM volume peaking in the prepubescent/early pubertal period followed by reductions in GM volume through cell death, the removal of redundant or unused synapses, and increases in myelination (Brown & Jernigan, 2012). Increases in myelination are included in the overall reduction of GM volume because prior to myelination neuronal axons form part of the GM.

Through postmortem studies and neuroimaging studies (including longitudinal structural and functional imaging studies) the time course of neuroanatomical

development of the human brain has been well established. Furthermore, intersectional reviews of postmortem, neuroimaging, cognitive, and behavioral studies have provided significant evidence that "brain development [,] cognitive [development,]…and behavioral development…occur concurrently during childhood and adolescence" (Casey et al., 2005, p. 104). Additionally, structural neuroimaging has provided a comprehensive understanding of age-based changes in grey and white matter volumes. Together these advances have opened the door multiple avenues of research to better understand this formative period of development.

During the life-course the first neural areas to mature are motor and sensory systems. Next, temporal and parietal association cortices involved in language and spatial attention mature. Lastly, high-order association cortices such as prefrontal (PFC) and lateral temporal mature and "integrate primary sensorimotor processes and modulate basic attention and language processes" (allowing for the top-down control of thoughts and action) (Casey et al., 2005, pp. 104 & 108).

> The development of the prefrontal cortex is thought to play an important role in the maturation of higher cognitive abilities. Mature cognition is characterized by the ability to filter and suppress irrelevant information and actions (sensorimotor processes), in favor of relevant ones (i.e. cognitive control). A child's capacity to filter information and suppress inappropriate actions in favor of appropriate ones continues to develop across the first two decades of life, with susceptibility to interference from competing sources lessening with maturity. (Casey et al, 2005, p. 106)

As mentioned previously, adolescence (~12-25 yrs.) is a time of extreme neuroplastic changes in the developing brain. The brain, unlike other organs, "undergoes significant changes in both its structural architecture and functional organization across [an animal's] lifespan" (Casey et al., 2005, p. 104). These changes, especially greater maturation and incorporation of prefrontal cortex (PFC) and structures that support the function of the PFC, along with increased "synaptic pruning, elaboration of dendritic arborization, and increased myelination... [allow for the development of]…the capacity for abstract thought, planning, and cognitive flexibility" (Luna et al., 2001, p. 786). Thus, during adolescence, there exist cognitive deficits that are only fully resolved in the latest stages of neural maturation. An example of one prominent deficit is found in the voluntary suppression of responses to task irrelevant information, which have been assessed historically with Stroop tests, Go/No-go tasks, and antisaccade tasks.

Current models suggest that as maturation of the striatum and the limbic system in general completes by early adolescence these areas—which are involved in emotional salience, gating, and approach and avoidance behaviors and that are sensitive to reward and novelty—are able to "override" the outpaced prefrontal cortex (Casey & Jones, 2010). The prefrontal cortex is the association area of the frontal lobe and in addition to being the phylogenetically newest brain region, is involved heavily in top-down control, language production, memory, and is an important part of a social processing network involved in self vs. other processing, higher order abstraction and theory of mind (Fuster, 2002). Of particular importance in the adolescent restructuring event is the loss of dopamine D1 and D2 receptors that proliferated during late childhood in the frontostriatal region and then become unavailable as maturation progresses (Casey & Jones, 2010). The

frontostriatal circuit—generally believed to involve the orbital frontal cortex, inferior frontal gyrus, and dorsal and ventral striatum—has been linked to social processing and social appetitive behavior and may be linked to social eating disorders (Somerville, Jones, & Casey, 2010). Larson and Luna (2018) suggest that the adolescent neural remodeling period fits the criteria of being a change in excitatory/inhibitory stasis and thus qualifying as a critical period in brain development. The authors implicate age-mediated increases in parvalbumin positive GABA interneuron networks and $GABA_A$ receptor $\alpha 1$ subunits in conjunction with changes to N-methyl-D-aspartate (NMDA) receptor subtype NR1 and NR2B availability, and changes in brain derived neurotrophic factor (BDNF) expression in linear increases in top-down control of prepotent responses and behavior and cognition response-gating (Larson & Luna, 2018).

While pubertal maturation and neural maturation overlap temporally and exhibit interconnectedness, these maturational events are distinct and neural maturation occurs over a longer portion of the adolescent epoch than does sexual maturation. Additionally, except for sexually dimorphic regional maturational trajectories that are influenced by sex hormones, the overall maturational event appears either weakly or not at all influenced by the presence of sex hormones—as evidenced by neuromaturational studies that have employed gonadectomy (Goddings, Peper, Crone, Beltz, & Braams, 2019). In short, castrated animals did not develop sexually dimorphic regional differences, but did undergo neural remodeling of all expected brain regions within the expected time frame (Sisk & Foster, 2004; Goddings et al., 2019). Additionally, the introduction or removal of sex hormones in the brain did not lead to increases or decreases in adolescent typical behavior attributable to the hormone intervention.

Recently, in a particularly elegant human subjects study investigating associations between pubertal hormone levels and reward processing in peripubescent girls and boys (n=79; 47 girls; ages 10-13) Ladouceur et al. (2019) found a negative association between striatal activity and estradiol level. While the authors appeared confused by this finding (citing positive correlations between gonadal testosterone levels and risky decision-making in a similar study), these results are consistent with emerging evidence for puberty as a catalyst for adolescent neural remodeling onset, but not as a driver for risk vs. reward salience and motivation. Thus, the dual systems model remains the best available framework for understanding adolescent typical behavior when considering evidence from across species and levels of analysis.

Long before G. S. Hall made puberty the focus of his adolescent period, non-scientific and pseudoscientific observations pinned the blame for stereotyped behavioral tendencies during adolescence/youth on puberty. Sexual maturation has held such a dominant place as a candidate explanation for adolescent behavior that it has become synonymous with adolescence to many. However, puberty is a discreet event that occurs during adolescence but ends prior to the completion of adolescence (as a developmental period). Briefly, puberty is the neurobiological and physiological process of becoming sexually mature, or able to reproduce (Sisk & Foster, 2004). It is summarized as a period of activation (disinhibition) of the hypothalamic-pituitary-adrenal (HPG) axis which results in a cascade of events starting with increased pulsatile releases of gonadotropin releasing hormone (GnRH), luteinizing hormone (LH), and follicle stimulating hormone (FSH) and ending with the production and release of gonadal steroids (and spermatogenesis in males) (Rosenfeld & Nicodemus, 2003; Sisk & Foster, 2004;

Emmanuel & Bokor, 2019). However, the interconnectedness of the two maturational events makes their intersection an exciting area of research. Some possible future directions may be examination of vertebrate orthologs of the RNA-binding factor *alan shepard* (*shep*; ortholog MPP family) (see studies on shep for neural remodeling during metamorphosis in *Drosophilia*, Yaniv, Issman-Zecharya, Oren-Suissa, Podbilewicz, & Schuldiner, 2012; Chen, Gu, Pham, Zachary, & Hewes, 2017) or studies designed to gain a better understanding of the interaction effects of sex steroids on fibroblast growth factors (FGF) (Jiang et al., 2013) in the central nervous system (CNS).

The human brain has been observed to follow a maturational trajectory that supports maturation of evolutionarily more ancient cortical and subcortical structures before newer brain structures. Additionally, maturation occurs in primary, secondary and tertiary sensory and motor cortices before maturation of association areas and then follows a posterior to anterior orientation. Primary, secondary and tertiary cortices are those regions of the brain that process sensory information and control motor output. These cortical areas have fewer neurons between the afferent sensory transducing receptors and the efferent processes involved in motor responses. Moreover, following the evolution of the nervous system, primary cortices and their afferent and efferent processes have direct lineage to simple sensory–motor nervous systems found in animals like *Hydra littoralis* (Swanson, 2012). These areas include motor cortex, somatosensory cortex, occipital pole (V1), and the frontal pole (Taki & Kawashima, 2012). Association cortices are involved in multimodal integration of information and in emotional and behavioral control. Because, these areas mature last, prior to maturation integrative networks are less efficient and have shorter regional connectivity.

While the exact triggering mechanisms remain elusive, progressive and regressive remodeling of the adolescent brain (between 12 and 25 years of age) leads to cognitive changes in humans and behavioral changes, conserved across many species, that aid in the navigation of complex, fluid, and often ambiguous ecological problems, and ultimately independence from the natal unit (Spear, 2000; Crews, He, & Hodge, 2007; Spear, 2011; Gomes et al., 2016; Romeo et al., 2016). As a result of the neuromaturational processes, adolescents show deficits in cognitive control and socioemotional processing that decrease inversely with age (Somerville, Hare, & Casey, 2011). For example, Veroude, Jolles, Croiset and Krabbendam (2013) used functional magnetic resonance imaging (fMRI) to study changes in cognitive control mechanisms between late-adolescents (18-19) and young-adults (23-25) on a cognitive and emotional stroop task. They found that on cognitive control measures the 18–19 year-old subjects had less activation of the dorsalmedial prefrontal cortex (dmPFC), left inferior frontal gyrus, left middle temporal gyrus, and middle cingulate when compared to 23–25 year-old subjects; and on emotional tasks the same age-based pattern continued with reduced activation of the dlPFC and the precuneus.

The social brain network.

When compared to other social mammals including all large-brained primate species we (*Homo sapiens sapiens*) are superlative in every measure of reciprocal and non-reciprocal altruism, complexity and breadth of our social networks, and empathy towards conspecifics and heterospecifics alike (Adolphs, 2009). The ability to navigate our extremely complex and broad social world requires a social brain; that is, neural

regions and functional neural networks that preferentially activate in the presence of, or when thinking about, conspecifics.

Moreover, humans are universally prosocial, and research has shown that across cultures prosociality emerges at roughly the same time developmentally (Callaghan & Corbit, 2018). Thus, despite different social ecologies with differing social, structural, and historical pressures prosociality will emerge as a function of our evolutionary inheritance—further indicating a role for the brain. Using functional neuroimaging methods like fMRI and PET, researchers over the past three decades have been slowly able to elucidate a large portion of just such a functional modular network—sometimes referred to as the social brain network (SBN) or more simply *the social brain* (Kliford, Garrett, & Blakemore, 2016).

According to Kliford et al. (2016) the social brain is involved in a wide range of processes such as: (a) face perception, (b) attention, (c) inference (d) reasoning, and (e) mentalization. Initial conceptualizations of the SBN included just three structures (Johnson et al., 2005): (a) the Superior Temporal Sulcus (STS) involved in auditory social perception, integrating visual cues about conspecifics, and theory of mind (Allison, Puce, & McCarthy, 2000; Zilbovicius et al., 2006); (b) the Fuciform Face Area (FFA) involved in face perception; and (c) the Orbitofrontal Cortex involved in emotional processing and self-monitoring (Beer, John, Scabini, & Knight, 2006).

Many of these neural regions and networks are the same as those that undergo significant neural remodeling between approximately the 12^{th} and 25^{th} years of life. As a result, it is quite possible that adolescents engage with their social environments differently than adults. Moreover, the difference in speed of maturation for parts of the

brain involved in emotion, salience, approach vs. avoidance, etc. and those involved in cognitive and affective control are also shown to have significant impacts on maladaptive social appetitive behaviors and intergroup behaviors.

Across adolescence and adulthood, whether one is bullying, being bullied, or just having a nice conversation, social-cognition–specific functionally connected brain regions work in concert to process the social information being presented. In line with maturational trajectories, behavioral observations, and survey results, social cognitive abilities gradually increase as a function of age. In a recent fMRI study testing intergroup bias within the social brain hypothesis Greven and Ramsey (2017) found significant functional network connections between regions associated with body perception (extrastriate body area [EBA] & fuciform body area [FBA]) and those associated with theory of mind/mentalizing (temporoparietal junction [TPJ], temporal pole [TP]; precuneus [PrC], and medial prefrontal cortex [mPFC]), which is interpreted as a functional integration of physical features and trait knowledge allowing for the neural encoding of identity representations. As individuals age, neural networking becomes more distributed and efficient, and as a result, improvements in top-down control of prepotent responses occur, self-other distinctions become clearer, and theory of mind further develops to allow for mentalizing about abstract others.

Luna et al. (2001) used an antisaccade vs. prosaccade task to assess neural maturation of response inhibition across age groups via functional magnetic resonance imaging (fMRI). Briefly, an antisaccade paradigm requires participants to suppress reflexive eye movement to a novel stimulus and fix their gaze at the mirror location to the novel image (Luna et al., 2005). Through this paradigm the researchers found, that in

addition to greater involvement of the dorsal lateral prefrontal cortex (DLPFC) during adolescence, a significant increase in striatum was present in adolescence but not childhood. The authors concluded that the recruitment of striatum indicates maturational processes of cortico-striato-thalmocortical loops that were present in adult participants and included: frontal eye field (FEF), intraparietal sulcus, thalamus, lateral cerebellum, dentate nucleus of the cerebellum, superior colliculus, and prefrontal and premotor areas. These results lend support to the theory that network maturation during adolescence is as important as prefrontal cortex maturation.

However, it should be noted that the specific networks elucidated by Luna et al. (2001) are related the antisaccade paradigm and cannot be generalized to all high order response inhibition tasks or scenarios. Additionally, it should not be assumed that the network delineated above is the only neural network undergoing maturational processes during adolescence—it is simply used as an example of the simultaneous maturation of prefrontal cortex and subservient networks.

A more general explanation of the structural and cognitive maturation course is given by Casey et al. (2005). They state that during maturation:

> [A] general pattern of increased recruitment of slow maturing prefrontal cortex, especially dorsolateral prefrontal cortex and ventral prefrontal cortex, and decreased recruitment of lower level sensory regions, including extrastriate and fusiform cortex and also posterior parietal areas…[t]his pattern of activity, which has been observed across a variety of paradigms, suggests that higher cognitive abilities supported by association cortex become more focal or fine-tuned with

development, whereas other regions not specifically correlated with that specific cognitive ability become attenuated. (P. 107, figure 1)

As mentioned briefly before, increased myelination is a key component in neural maturation during this period. Late myelination has been shown to take place during adolescence in particularly late maturing neural association areas (e.g. the frontal and parietal cortices). In fact, increases in myeloarchitecture during this period is hypothesized to be the reason for decreases in grey matter volume noted in many neuroimaging studies. In other words, adolescents are not losing grey matter, but are instead gaining significant white matter. The net result of this late myelination is "faster and more efficient sharing of information within, for example, various fronto-cortical circuits, as well as smooth communication between the frontal cortex and other cortical and subcortical regions" (Paus 2005: 62).

According to Kilford et al. (2016), brain areas associated with the social brain network are some of the latest maturing areas of the human brain. Additionally, many of the areas implicated in the social brain network fall within the maturational imbalance described by the *Dual Systems Model* of brain development, which is used as a guiding theoretical framework for the present study. For example, IFG which is implicated in cognitive control and is in a protracted immature state, is also implicated in the ability to make sense of social situations and in action observation (Kilford, et al., 2016). Other areas like the anterior temporal pole and the amygdala, which are not specifically mentioned in the *Dual Systems Model,* are known to be well connected to structures central in each of the *Dual Systems'* "systems." For example, robust amygdala connectivity with the OFC is well studied (Moll et al., 2002). According to Moll et al.,

the amygdala connectivity is especially strong at the lateral OFC, which has been implicated in reward and punishment processing (2002). Recently, cellular-level sub-networks in the OFC (ventral-socioemotional network) regulating social monitoring and feeding behavior were defined and were found to be interconnected with social influences significantly impacting feeding behavior (Jennings et al., 2019). Under the *Dual Systems* framework, socially-mediated appetitive behaviors such as anorexia and binge eating may have explanations in the mismatch between VS and OFC (i.e., an immature OFC is less able to downregulate VS input). Extending the OFC, VS, AMY network to intergroup bias, developmental mismatch may result in a decreased ability to monitor and control base responses to outgroup members—especially in the presence of approving coalition members.

In addition to cross-over between the *Dual Systems Model* and the Social Brain Network, recent research has found that beyond "system competition" (see Chapter three), a more nuanced approach to understanding adolescent behavior includes protracted distribution of functional networks alongside regional maturation. In a series of fMRI studies summarized by Sebastian, Burnett, & Blakemore (2008) general findings were that adolescents' development of distinct self–other processing progresses with age, and by late adolescence (~20-24) a shift between anterior (dorsomedial PFC [DMPFC]; BA 10) processing to more posterior structures including the superior temporal gyrus and fusiform gyrus occurs which allows the individual to incorporate a wider more other-focused view of a social environment. Generally, when asked to think about themselves and their own preferences, adolescents activate DMPFC, whereas adults activate posterior temporal regions indicating that adolescents use an "in the moment" evaluative

strategy while adults access memory of self to complete the task. Sebastian et al. (2008) suggest that these results can help explain the imaginary audience phenomena common to adolescents wherein they feel watched or judged even when the assessment is illusory. Further, imaginary audience and in-the-moment self-evaluation may explain why adolescents are more susceptible to peer influence (Sebastian et al., 2008).

Additionally, studies have shown decreases in medial PFC (mPFC) activity for adults relative to adolescents on mentalization tasks (e.g., judging communicative intention of another or thinking about the preferences of a fictitious other) and have indicated that adolescents vs. adults employ different mentalization networks (Blakemore, 2012). Findings, like those reported by Blakemore, are intriguing through the lens of intergroup bias, because differences in the ability to decode outgroup member communications or think about the preferences of a fictitious other, coupled with adolescent-typical behaviors, may shed light on differential age-based contributions to active gang-, hate-, and religious fundamentalist-group activity—all of which require regular ingroup vs. outgroup computations. However, there remains much more to learn about the functional connectivity of sub-networks that facilitate social cognition (Adolphs, 2010). For example, how does adolescent neural restructuring impact the SBN, and what explanatory power does that have for investigations of intergroup bias where adolescents are the aggressors?

Intergroup Bias

More than a century has passed since ethnocentrism—first described by Gumplowicz—received the foundational refinement by William Graham Sumner (ref. *Folkways, 1906*) that introduced ingroup social cohesion and outgroup derogation for the

purpose of ingroup capital management (Bernard, 1940; Brewer, 2007; Bizumic, 2014). Since the publication of *Folkways,* several models of intergroup bias have been advanced to understand and predict coalitional behavior (Insel & Fernald, 2004). Like many of our primate cousins (e.g., Rhesus Macaques & Chimpanzees) we subdivide our social worlds into ingroups and outgroups (Hewstone, Rubin, & Willis, 2002; Mahajan, Martinez, Gutierrez, Diesendruck, Banaji, & Santos, 2011; Cikara, Van Bavel, Ingbretsen, & Lau, 2017). In other words, social divisions are made based upon "us" (we) and "them" (they) categorical distinctions that are illusory biologically but that have been socially constructed and are reinforced through historical precedent and structural protection. In the U.S. race-based intergroup bias receives the most attention, however, "us" vs. "they" categorizations are not limited to this manifestation.

While humans are sensitive to visual stimuli, because language emerged long before visual distinctions in human tribal groups did (Antón, 2003; Willems & van Schaik, 2017) it is likely that accent and dialect are more potent indicators of group membership than phenotypic morphological variance related to skin tone, hair color and type, and eye color and shape. Whatever the modality, humans categorize everything, especially their social worlds, and this propensity to categorize emerges early in infancy and without impingement by history, biography, or structure (Mahajan et al., 2011). To make matters more complicated, ingroups are not static coalitions, so they are continually updated to incorporate membership (past and present), status hierarchies, and debts. Thus, ingroups take up a significant amount of cognitive "space" and play an important role for much of the lifespan. At no other time in life is the importance of putting in the work of coalitional membership more acutely felt or observed than during

adolescence/young adulthood. As a result, intergroup bias and conflict during adolescence—as it is defined maturationally—is an important and underexplored area of research. The maturational definition of adolescence is important in this case because for most Americans, neural maturation will not have completed by the time adult roles are accepted, and no Americans will have achieved cortical maturation by age-of-majority. Maturational processes making adolescents vulnerable to intergroup conflict will continue to do so regardless of role or status, therefore the full 12 – 25-years-of-age block should be examined.

In short, (a) humans naturally divide their worlds into "us" vs. "them" groups, (b) intergroup bias is the result of positive evaluations for the ingroup and negative evaluations for the outgroup, (c) during adolescence peer salience is heightened, (d) during adolescence peer approval is rewarding, (e) adolescent peer groups are not perfectly age-matched, (f) adolescence is a time of increased willingness to take risk, (g) adolescents are more emotionally tied to their friend networks than children or adults, (h) adolescent frontal and parietal networks in the social brain circuit are not refined, nor are the frontostriatal circuit, dopaminergic pathways, changes to GABAergic concentrations of parvalbumin positive GABAergic medium spiny neurons (MSN) and $GABA_A\ \alpha 1$ receptor subtype availability (along with many other neurochemical changes), (i) therefore adolescents are more vulnerable than individuals at other ages for recruitment into ultra-tribalistic groups and are at increased risk for perpetrating acts of intergroup bias against outgroup members, including coalitional violence.

Therefore, as forecast by early pragmatists Cooley, Dewey, and G. H. Mead (Moula, Timpka, & Puddephatt, 2009), a better understanding of how neuromaturational

trajectories impact the social brain and ultimately behavior is vital (Simi, Windisch, & Sporer 2016; UNDP, 2016). Brain activation of stereotype responses are extremely fast and initiate outside of conscious awareness (making EEG's extremely fine temporal resolution ideal for intergroup bias research). Initiation of intergroup bias in the form of stereotype or prejudice does not, however, predict that a behavioral response (discrimination) will be made. Neural networks engaged in conflict monitoring and the suppression of socially undesirable behaviors require functional connectivity provided by neural maturation as well as social education and practice inhibiting responses (Bartholow, Dickter, & Sestir, 2006).

One of the most pernicious forms of intergroup bias, that seems resilient to practiced inhibition, is prejudice, because it involves emotions and coopts appetitive cues like disgust, prejudice may lead to more aggressive forms of discrimination. Whereas stereotypes are heuristic devices that may lead one to insensitive or hurtful behavior without an intent to do harm, prejudice, according to Amodio (2014) involves fear, disgust, and hatred—however stereotype and prejudice are most often acting in concert and not separable (Plous, 2003). Fear, disgust, and hatred are more likely to compel an individual to preemptively strike an outgroup than a neutral observation that another person belongs to a group to which you do not belong (Mifune, Hizen, Kamijo, & Okano, 2016). Amodio (2014) described a neural network for prejudice centered on the amygdaloid bodies and projections to the orbitofrontal cortex (vmPFC, control, decision making, emotion regulation, appetitive behavior), insula (disgust), anterior cingulate cortex (control), and PFC (higher cognition, memory, and control). Many of these areas will be recognized from the previous discussion of the social brain network, as well as,

neural maturational trajectories. Drawing inference from the maturational literature and implications from the prejudice circuit it is possible to assume that prejudicial assessments are more difficult for adolescents to suppress and more emotionally "potent."

In addition to neurobiological processes that increase peer salience during adolescence, joining peer and intergenerational coalitions can act as a stress buffer for adolescents that do not possess additional "psychological resources" (i.e, sense of control, purpose, positive affect, etc.) (Chiang et al., 2018). Adolescent social coalitions provide a safe closed-group for socialization opportunities, and thus direct the personality development of the constituent members (Reitz, Zimmermann, Huttemann, Specht, & Neyer, 2014). However, they also provide opportunities for bullying-for-status and intergroup conflict with outgroup members. McFarland, Moody, Diehl, Smith, & Thomas (2014) remind us that the literature on adolescent social networks finds that adolescent ingroups are highly segregated, vertically-stratified, and have relatively impermeable borders.

Connecting the coalitional socialization process with intergroup bias, Elder, Jr (1971) states that "[w]hen the relationship between children is socially defined by the status and image of their respective membership groups, intergroup conflicts are likely to generate consciousness of identity and loyalty" (P. 151). In an interesting way the adolescent ingroup becomes both a primary group and a reference group for its members. And whether intergroup conflict occurs, the establishment of group identity—even under minimal conditions—has been shown to increase intergroup bias (Tajfej, 1969; Tajfej, Billig, & Flament, 1971).

Though it is important to recognize that not all intergroup conflict is a result of intergroup bias. In adolescent school-networks, current evidence calls into question models of bullying behavior wherein the bully is framed as "acting-out" because of some trauma at home or past physical or relational aggression experienced, and frames bullying behavior in the wider social context of status hierarchy (Faris & Felmlee, 2014). Inter- and select intra-group aggression can be status enhancing, and particularly so within a compressed hierarchical system such as school or corporate workplace. For example, in an examination of adolescents in a compressed system (i.e. an organizational structure wherein hierarchy is fixed), Faris (2012) found that among high-status individuals, the most successful systematically maintain coalitional bridges (i.e., maintain small, exclusive ingroups that cooperate with other small, exclusive ingroups of equal status) between ingroups and neutral (noncompetitive) outgroups and direct relational aggression to further attain status or penetrate least-permeable group boundaries. Thus, background (e.g., SES) may lend some benefit, but status maintenance and mobility require considerable work.

Literature Review Conclusion

The preceding chapter provided a brief background covering many academic areas of research and thought. Divided into two parts, the first half of the review took a historical perspective and (a) briefly reviewed the longevity of adolescence as a concept; (b) challenged a view of adolescence as an invention of American industrialization; (c) reexamined G. Stanley Hall's contribution to adolescence research; and (d) explored classical and contemporary sociology of adolescence. The goal of the first-half of the review was to gain a better understanding for how sociological thought on adolescence

coalesced and became reified in the present form; a form that considers recent history, personal biography, and social and cultural structure, but does not find explanatory value in evolutionary history or biological explanations.

The pervasive nature of Hall's views on adolescence and the subsequent reaction to these views from sociology and anthropology may provide the answer. Prior to the revolt against Hall's outlook, not only did sociological social psychology dominate sociology, but as with psychology, experimental methods were being developed and refined to better understand social phenomena under controlled conditions (Brearley, 1931). However, experimental sociology and the dominance of sociological social psychology were not long-lived (neither being affected by Hall). Hall's claims had serious flaws, and as shown in the review, these flaws were noticed by Hall's colleagues in psychology. Sociological and anthropological work on adolescent behavior—especially during transition to adulthood—further discredited Hall's conclusions regarding the universal nature of storm and stress. And while Hall may have written much more than on just storm and stress, that is what caught the attention of researchers, clinicians, and judges.

Sociologists and anthropologists noticed variance in the transitional timing and the behavioral manifestations. That is, some people transitioned at 18 with no behavioral problems and some in their mid-twenties with great disturbance. Transition appeared to depend upon culture, structure, and maybe personality, but not puberty. Based upon the claims of Hall, the understanding of human biology available in the middle of the 20th-century, and less precise technology coupled with contrary observational evidence it is understandable that sociologists of the 1930s and 1940s abandoned the bad biological

models on offer (or at least withheld judgment for better information). The tacit claim made herein is that if one wants to understand the sociology of adolescence—specifically its particular dogmas—one must understand Hall and his influence. Additionally, it is important to understand the genesis and life-course of the industrialization-myth, that is, that adolescence was invented as a byproduct of industrialization. Not does understanding the industrialization story give a history for our own claims, it provides (along with the sociology of adolescence framework) a better understanding for how sociologists, psychologists, and biologists can miscommunicate about the same concept—adolescence. On one hand the word adolescence has a long history as a label for a developmental stage; on the other hand, the same word has come to represent the concept of a social transition space between childhood dependence and adult independence—demarcated by roles and responsibilities. Both sides have historical claim to word usage in their favor but seem to have considerable trouble unifying the two usages—which, may be the first step for a meaningful theory of adolescence and adolescent behavior.

From a sociological perspective, 2019 is not 1930 and the arguments used against Hall's conceptualization of adolescence as a universal developmental period, with puberty as its mechanism of action, should be reexamined. The second-half of the literature review covers neurobiological changes during adolescence and how those changes impact and change circuits in the brain involved in social cognition, cognitive control, and emotions. The second-half of the review concludes with a short discussion of the literature concerning the neurobiology of intergroup bias. In order to fully appreciate the changes that occur in the adolescent brain, it is better that the sociological social psychologist conceptualize the adolescent as having a different brain during adolescence

than they will during adulthood—the remodeling is that significant (as shown in the review). Therefore, understanding the limits of the adolescent brain and any differences between the adolescent and adult brain, at the group level, is vital for explanations of identity, role, and social behavior. Moreover, it requires sociological social psychologists to pursue basic research agendas aimed at uncovering the differences between the adolescent and adult brain until such time as that line of research is no longer necessary. Where current sociological and psychological social psychology theories fail to offer viable explanations for differences in neuroanatomy during neuromaturation and neuroendocrine driven behaviors, appropriate theory must be imported from the relevant neuroscience subfield. The present research does exactly this by importing the dual systems model of brain development.

Chapter Three: Theoretical Framework

Chapter three reviews the *Dual Systems Model* (DS) of brain development to better understand how neuromaturational changes during adolescence lead to increases in risk-taking behaviors. Furthermore, DS is extended to better understand intergroup bias and differences in social cognition during adolescence through the recognition that (a) risk-taking is linked to other common adolescent behaviors, and (b) many of the neural structures and circuits implicated in these behaviors due to "developmental mismatch" are shared with circuits involved in social cognitive processing and self-identity. Developmental mismatch occurs when limbic structures involved in emotion, reward, and approach/avoidance gating mature before prefrontal structures involved in regulating the behavioral output in response to limbic signaling (Mills et al., 2014). Because the present research is at the forefront of scientific and theoretical understanding of possible linkages between neural maturation and social processing vis-à-vis intergroup bias, theoretical extensions to DS based upon a synthesis of the known neuromaturational processes, maturation in the social brain network, and neurobiology of intergroup bias (in general) presented in the literature review are required. The dual systems model is certainly not the best explanatory model; however, it is currently the best explanatory model proposed, and is supported by considerable evidence (Shulman et al., 2016). Other proposed models such as the triadic model were intriguing "on paper" but have failed to meet the evidentiary burden (Willoughby et a., 2014; Shulman et al., 2016). Furthermore, because candidate explanations that include viable, up-to-date models of human neurobiology are absent from sociological social psychological theory and sociological theory, an external

theoretical model that can account for variance between age–cohorts at the level of the brain and outside of conscious appraisal was necessary.

The overview of DS covers primary brain structures and circuits proposed by the delayed mismatch hypothesis. The chapter then explores some of the ways that DS can be extended to questions of intergroup bias, and social cognition generally. Much of the theoretical detail (structure – function) relies upon the literature reviewed in the previous chapter and, for brevity, will not be repeated. Finally, the chapter is concluded by suggesting possible way in which sociological social psychology research can incorporate DS into current models of the human life-course.

Dual systems model.

The *Dual Systems Model* is an empirically driven neurobehavioral model that was developed independently by two developmental cognitive neuroscience laboratories (the Steinberg Lab at Temple University & the Casey Lab at Cornell University) in 2008 to explain linkages between the maturational timing of brain regions and functional circuits and the appearance of adolescent-typical behaviors (risk-taking, reward-seeking, sensation seeking, peer salience (Shulman et al., 2016). While DS was originally focused on providing explanations for adolescent risk-taking, the interconnectedness of systems that allow for heightened risk-taking also affect the other adolescent-typical behaviors. In short, the adolescent typical behaviors can be thought of as a behavioral suite that are not dissociable.

According to Spear:

> An adolescent-associated increase in risk taking is seen in a variety of species and may provide the opportunity to explore new behaviors, situations, and reinforces. Increases in the value attributed to social interactions with individuals outside the natal family unit likewise may serve to promote independence. (2000, p. 420)

Thus, in order to understand the common behaviors associated with adolescence it is important to also view them through an evolutionary lens, and to keep in mind that (a) these behaviors are conserved across a variety of species indicating their ancient origins and either continued conferred survival advantage or a net neutral effect, and (b) that humans in 2016 are not fundamentally different from early modern humans, or in may regards from other animal species. Because the evolution of a species is an extremely slow process, we would not be expected to lose adaptive mechanisms for survival simply because human civilization has become extremely complex (compared with social ecological problems faced by our early modern human ancestors).

The *Dual Systems Model* proposes the existence of two interacting functional brain systems that have "mismatched" developmental trajectories (Casey, Jones, & Hare, 2008; Strang, Chein, & Steinberg, 2013). That is, one system matures more quickly than the other one. The result of the suggested mismatch is an imbalance between the two systems, wherein input from one system can "override" input from the other system. While there is still some disagreement concerning the exact trajectory timing between the Steinberg (2008) versus Casey (2008) versions of DS, both versions of the model agree that the systems involved are a ventral social-emotional system and a cognitive control

system (Shulman et al., 2016). Before explaining the "nuts and bolts" of DS is may be important to examine what is meant by systems and circuits.

Maturational differences between the two systems occur in the context of larger neural restructuring events. As the brain matures the two systems work together and functional circuits emerge for the processing of stimuli. For example, in the mature brain incentive processing relies on a distributed functional network including the striatum, midbrain, amygdala, orbitofrontal cortex, medial and lateral prefrontal cortex, and posterior parietal cortex (Geier & Luna, 2009). As one will gather from the discussion below, incentive (reward) processing in the adult brain relies on both the ventral and dorsal lateral systems working in concert. Adolescence represents a unique time when system division is driven by maturational timing, but many of the system distinctions blur as the brain fully matures.

The ventral socioemotional system.

The ventral socioemotional system (VSES) is all about reward and its pursuit (Shulman et al. 2016). The VSES includes a functional circuit between the striatum and the orbital and medial PFC (Shulman et al., 2016). According to Shulman and colleagues the VSES is an "early-maturing incentive-processing system…[that]…amplifies adolescents' affinity for exciting, novel, and risky activities…" (2016, p. 104). There is abundant evidence of maturational mismatch between subcortical limbic structures such as the amygdala (AMY), located in the medial temporal lobe, and the nucleus accumbens (NAcc) or ventral striatum (VS) located in the basal ganglia, and the prefrontal cortex (PFC) located at the anterior aspect of the brain (Casey, Getz, & Galvin, 2008; Steinberg,

2008). Early maturation of structures involved in reward (NAcc) and emotional salience (AMY) allows for a disproportionate impact on behavioral output.

While the amygdala may play a role (empirical support is currently low; Shulman et. al, 2016), the ventral socioemotional system is dominated by functional connectivity between the ventral striatum (VS) and the ventral medial PFC (vmPFC; also known as the orbitofrontal cortex, OFC) (Strang et al., 2013). The VS or Nucleus Accumbens (NAcc) is a well-known limbic structure dedicated to "reward" processing. During adolescence fMRI studies have revealed peer-approval as a potent "reward" mechanism for adolescents at the level of the Nucleus Accumbens (NAcc/VS) (Meuwese, Braams, & Güroğlu, 2018). This is an important finding because reduced ability to regulate a behavioral response in the presence of rewarding peer-approval or its anticipation when conforming to peer-approved behaviors may explain some deviant, coalitional adolescent behavior.

The control system.

The control system involves the dorsolateral prefrontal cortex (DLPFC), Ventrolateral prefrontal cortex (VLPFC), anterior cingulate cortex (ACC), and the lateral parietal lobe, and this functional circuit's maturation allows for consistent regulation of dangerous, socially unacceptable, or impulsive behavior. Importantly fMRI studies have linked activation of these regions with self-regulation—an operation that requires self-other/self-object distinction and the ability to project oneself backward and forward in time. As stated in chapter two, despite its overall role in top-down control of cognition and behavior and higher order cognitive functions, the PFC is heterogenous and those areas of PFC that can be described as "purely association cortex" have interconnected but

varied functions due to variance in local, regional, and global network circuitry. For example, the VLPFC area known as the inferior frontal gyrus (IFG) is well known for both top-down control function, as well as, language functions. However, IFG based upon the functional network analyses, fMRI studies of cognitive control, and lesion studies IFG appears to primarily control emotional responses to threats or other highly salient stimuli (Morawetz et al., 2016). Maturation of control ability in the face of threatening stimuli is particularly important when considering adolescents' abilities to process outgroup information—especially when competing, peer-driven, reward signaling for maladaptive, coalitional outgroup-directed verbal and/or physical violence is present. As noted by Somerville et al. (2011) and Veroude et al. (2013), activation of IFG-mediated control is inconstantly applied in adolescents, despite the IFG playing a prominent role in control function prior to greater distribution of control function. The same authors demonstrate that with age, not only is control function more robust, but it is better distributed and begins to rely more heavily on posterior regions. In contrast to VMPFC, DLPFC is primarily involved in maintaining representations for immediate action selection (Mars & Grol, 2007). This makes sense on its face due to DLPFC proximity to primary and secondary motor cortex and is supported by numerous fMRI and transcranial magnetic stimulation (TMS) studies in human- and non-human primate studies (Mars & Grol, 2007). Action selection necessitates control, or the suppression of unwanted action in favor of the desired motor response. Because DLPFC is heavily networked with posterior structures associated with social cognition, self-reference, and higher-order abstraction, maturation-based deficits in the functional networks or structures is important in conversations of adolescent intergroup bias. According to

Bicks, Koike, Akbarian, and Morishita (2015), DMPFC consistently activates when one mentalizes about others. Therefore, maturational deficits in the ventral socioemotional network (particularly in OFC regulatory function) and reduced and inconsistent activation of control mechanisms in the VMPFC coupled with weak networking and an immature DMPFC may result in highly emotionally driven action selections, which could be devastating in a particular social ecological context. One future line of research may be to investigate maturational differences in the functional networking between DLPFC and transmodal cortex in adolescents and adults to uncover how maturation affects action selection to complex social stimuli.

While the control system involves multiple areas, distributed across the brain, current evidence suggests that expansion to the wider distribution of function emerges with maturation/age. Distribution of control function is evident in activation of the transmodal cortex areas including the inferior parietal sulcus (IPS) and includes the inferior parietal lobule (IPL), and the middle temporal gyrus (MTG), which provides input to anterior and inferior temporal regions and lateral and inferior prefrontal areas (Margulies & Smallwood, 2017). Additionally, the prefrontal cortex remains immature and undergoes a lengthy protracted maturational process during adolescence, during which cognitive control functions a regionally isolated to the IFG (lateral PFC) and are inconsistently activated. As a reference, the prefrontal cortex is generally divided into four functionally, heterogeneous regions—based upon standard anatomical naming convention, they are lateral, medial, and ventral (orbital) (Fuster, 2002). As a reminder, and broad generalization of the material covered in the literature review (Chapter 2), maturation of the PFC during adolescence is a protracted period of synaptic pruning,

functional network connectivity establishment, and myelinization. This restructuring event is underscored by changes in the GABA-ergic system, and neuropeptide synthesis and receptor availability particularly for glutamate and dopamine. For example, during early through late-mid adolescence (≈15 yrs.) humans reduce frontal-lobe density by ≈40% and reduce the number of dopamine and glutamate receptors by a comparable amount (Andersen, 2003).

Conclusion

The dual systems model is a general theory that explains behavioral, cognitive, and affective differences between adolescents and adults. It does not specifically address intergroup bias, but because of extensive overlap between those areas implicated by DS for adolescent typical behaviors and the brain regions and networks involved in social cognition, extending DS to adolescent intergroup bias as a heuristic model may allow for novel questions and insights. Moreover, because DS is based upon neurobiological evidence it is a useful theory for understanding differences in the spatial and temporal processing of intergroup stimuli—with the promise of self-updating as more becomes known about maturation and behavior. Inductive theory building starting with models like DS and empirical evidence from the two social psychologies will prevent future researchers from the unsightly task of "reinterpreting" deductive, arm-chair theories that are divorced from the empirical evidence and that do not lend themselves to testable and falsifiable hypotheses or scientific predictions vis-à-vis human social behavior.

It is clear from the extant literature reviewed in this dissertation that adolescents think about and weigh their social worlds differently than do adults. The present study is the first study that to apply DS to ERP research on intergroup bias comparing subjects

with fully mature grey matter against those still undergoing neural maturational processes. Use of DS as a framework directly informed both hypotheses in the present study and aided in the interpretation of unexpected results. However, because DS is limited in scope to maturational imbalance and the potential vulnerabilities associated with mismatch during adolescence, DS will have more explanatory power if joined with the social brain hypothesis and a unifying theory that considers environmental, evolutionary, and social ecological impacts explicitly within the model. The unified theory of development (discussion chapter) is promising in that it provides a framework that requires input from sociological, psychological, biological, and evolutionary level variables.

As noted in the literature review, distribution of function and the maturation of distributed networks appears to be as vital as regional changes. Therefore, DS will need to undergo further scrutiny before being accepted within a unified framework. For example, evidence suggests that the distribution of control function is not in place at an early age, or even throughout a large portion of adolescence (Sebastian et al., 2008). According to a review of evidence from human and non-human primate studies by Somerville, Jones, and Casey (2010), a key take-away regarding the neural mechanisms underlying DS is that immature ventral pathways between subcortical structures and prefrontal structures result in the most variance in performance on goal-directed, and cognitive control tasks between adolescents and adults. Another key take-away is that adolescent pathways are characterized as diffuse (but locally so) when compared to adult neural pathways. In other words, adolescents do not have the benefit of well-myelinated, non-redundant networks that engage high numbers of neural nodes on task performance

(when compared to adults). In 2013, Cristakou et al. (2013) conducted a series of fMRI-compatible Iowa Gambling Tasks (IGT) to investigate reward-mediated decision-making. Findings from their studies support the Sommerville et al. (2010) assessments of adolescent risk-taking and decision making. Cristakou and colleagues report that performance on IGT increased as a function of age as did subjective valuation of option choice (2013). As noted in the literature review, mismatch between cognitive control systems and socioemotional systems have wider implications for social cognition and intergroup bias during adolescence. Below a brief recap of some of these implications is provided before concluding the chapter.

The mismatch proposed in DS and the expanding system extension proposed herein do not suggest that all adolescents will engage in adolescent-typical behaviors in an extreme, or maladaptive fashion. Plainly, the evidence for the universal nature of adolescence and changes in the brain as its driver is overwhelming but does not discount the significant impacts of social ecological factors. Shulman et al. (2016) notes that studies of risk taking and sensation seeking in the laboratory have been "hobbled" by the inherently non-risky nature of IRB-approved studies (when compared with real-world risk). The same lack of real-world validity plagues sensation seeking studies, and both risk and sensation studies are in some cases forced to rely on self-report data (Shulman et al., 2016). As proposed in Chapter one, peer approval may be particularly rewarding to most adolescents and may result in some level of risk acceptance, but activities labeled "risky" will be determined by social ecological factors such as culture, context, socioeconomic status, and peer group make-up. However, a full understanding of the basic neural sensitivities and vulnerabilities, universal to all humans at a given point in

development, is necessary before the full weight of variation in local social ecological presentations can be grasped.

Additionally, many of the same areas implicated in adolescent-typical behaviors are also implicated in human prosocial behavior, the formation of *the self*, and other research areas of sociological social psychological concern. Understanding human brain maturation, as well as, neural structure and function can aid in the evaluation, modification, and potentially, support, of current theories. Everything that happens in the human world occurs in human brains, therefore, if a structure, process, network or function are proposed it should be investigated at the level of the brain. For example, it would be not terribly difficult to test Goffman's dramaturgical theory or Cooley's looking glass self, or any of Mead's thoughts on the mind and *self* using EEG and fMRI. There can be no reasonable explanation for not submitting micro-level theory derived hypotheses to this level of testing.

Chapter Four: Method

Recruitment Efforts

To better understand differences in social cognitive processing for ingroup vs. outgroup members in individuals with a still-maturing brain vs. those with fully mature brain two age groups were selected based upon a current understanding of neuromaturational timing. The adolescent group consisted of individuals between 18 and 19 years-of-age and the adult group consisted of individuals between 30 and 35 years of age. Age groups were selected to: (a) avoid maturational overlap with adjacent neuromaturational periods due to individual variation (i.e., late adolescence was selected instead of early or middle adolescence); (b) introduce a meaningful temporal buffer between groups so that no maturational overlap occurred with room for group age expansion (i.e., the adolescent could be expanded to include 20 and 21 year old individuals and the adult group could be expanded to include 28 and 29 year-old individuals); and (c) to provide a small buffer against normative cognitive (Salthouse, 2009) and motor (Thompson, Blair, & Henrey, 2014) decline in adult group members.

The following subsection outlines the efforts that were made, and the methods that were used to recruit subjects to the adolescent and adult groups. Recruitment began in December 2017 and ended in April 2019. A goal was set to recruit 50 subjects. Twenty-five subjects would be recruited between the ages of 18 and 19. Twenty-five subjects would be recruited between the ages of 30 and 35. The twenty-five-subject goal for each group was decided on based upon a pre-study power analysis using *G*Power* (Faul et al. 2007) that indicated recommended sample sizes of 18 subjects per group. The

additional seven subjects were requested from the IRB for each group to account for subject and data attrition.

Overall assessment of the sustained recruitment efforts is that they were unsuccessful. Despite new flyers placed at the beginning of the fall semester, spring semester, and summer only four of the 28 total subjects recruited reported that they were responding to the recruitment flyer. Of the remaining subjects, one subject contacted the laboratory after an acquaintance participated in the study and the remainder were recruited through the Sona Systems experiment scheduling system.

Flyer placement.

Flyers were placed on the USD campus on every pin-board available to the student body. Flyers were also placed in the following communities:

- Vermillion, SD
- Burbank, SD
- Meckling, SD
- Yankton, SD
- Tea, SD
- Sioux Falls, SD

Community flyer placement focused on public message boards and employee breakrooms and was primarily aimed at drawing in the 30–35-yr-old population. Total distance between furthest geographic points where flyers were placed (Yankton and Sioux Falls) was 79.3 miles. Placement included city and county government offices; police, fire, and medical services; education buildings (elementary-, middle-, and high-schools); restaurants and coffee shops; factories and manufacturing plants; and within “main-

street" businesses (e.g. insurance offices, banks, etc.) in Vermillion and Sioux Falls. Additionally, the Minnehaha County (SD) government emailed the flyer to all government employees, the USD Native American Student Center emailed the flyer to members, the flyer was emailed to USD physical therapy and occupational therapy students, and the flyer was emailed to the membership of Women in Biomedical Research. Flyers were replaced at the beginning of each school semester and at the beginning of the summer break (end of August, end of December, and beginning of May). Recruitment and the experiment continued during summer and during school holidays (e.g. winter break, spring break, etc.). On average 260 physical flyers were placed each semester.

Flyer design went through multiple iterations during the study; however, the core content was not altered. Due to the extreme difficulty recruiting from the 30–35-yr.-old population later versions of the flyer specifically targeted the 30–35-yr.-old population and no longer mentioned the 18–19-yr.-old age group (sample flyers are provided in Appendix B). This effort coincided with the addition of a second testing location in Sioux Falls, SD and did not impact 18 – 19-yr.-old recruitment because those subjects primarily completed the study for course credit and signed up via the Sona experiment scheduling system.

Sona recruitment.

Sona Systems ® software (https://www.sona-systems.com/default.aspx) is a cloud-based research management tool that allows for (a) survey design and administration; (b) experiment scheduling; (c) participant activity logging; and (d) electronic research administrative functions. Additionally, Sona provides a free application for apple and

android devices, which gives participants an easy and modern way to interface with the research (e.g., complete a survey or sign up to participate in an experiment). The addition of the phone/tablet application is useful for research with an undergraduate subject pool because of student comfort with application-based individual–organization contact.

Sona has become known for its use with data collection on undergraduate subject pools, however, the software is not specifically designed for research on undergraduate students and can be used to manage research administrative processes for study recruitment taking place within and without a university system. Limitations/restrictions on recruitment activities are set by each software license holder (department) and vary.

The Sona experiment scheduling system (*hereafter* Sona) used for subject recruitment in the present study is maintained by the USD Psychology Department and is made available to researchers within adjacent departments and disciplines engaged in social, behavioral, psychological, and neuroscience (human subjects) research. Subjects recruited via an account set up by the lab manager of the neuroscience laboratory of which the student primary investigator (PI) is a member. Thus, the following descriptions are specific to USD Sona policy and the restrictions placed upon non-psychology department researchers. The present study relied upon the undergraduate research pool for recruitment through Sona.

The undergraduate research pool consisted of students attending undergraduate courses requiring research participation for course completion. One option available to students with a research participation requirement is to participate in a study registered with Sona. For a study to be registered it must be approved by the IRB and is then subject to an internal approval process conducted by the USD Psychology Department. Once

approved, a researcher will create appointment timeslots by designating the date, length of time for the session, and interval between sessions (only true for in-person studies; survey researchers skip this step). Students pursuing “research credits” can accumulate points by participating in one or more studies listed on the University’s Sona page. Points earned can range from 5-points for a short survey to 22 points (as is the case for the present study) for participation in a longer in-person experimental design. The policy at USD is to award three Sona credits (points) for every 10-minutes of research activity (e.g., filling out a survey or participating in an experiment). Students also receive an additional two bonus Sona credits for participating in an experimental study. This is done to encourage first-year psychology students to become familiar with experimental research methods outside of the classroom. Sona credit allotment is decided by the researcher prior to study approval. Once a subject has completed a study, the researcher can award Sona credits by selecting a toggle button on the researcher graphic-user-interface. It is worth noting that the researcher for the current study was not affiliated with the department for which courses required study participation. No action was taken by the researcher beyond logging the credit received. Each course instructor is ultimately responsible for Sona credit application toward a final grade or course completion. Independence of the student PI from final credit allocation ensured that no undue influence from the research laboratory on the research subject was present (vis-à-vis Sona credit).

Availability of the undergraduate research pool was further aided by the Sona prescreen filters that allow for isolation of a target research population—making it ideal for the recruitment of undergraduates with desired demographic qualifications. For

example, Sona filters were set for the present study's recruitment so that only male students that fell within the two recruitment-age-groups were able to view or sign-up for participation. Eligible students are also able to view a detailed description of the study that lists: (a) additional inclusion/exclusion criteria; (b) purpose of the study; (c) the time required of the participant; (d) and experimental tasks and data acquisition methods used. All study related information viewed by potential participants and filters used to target participant populations were subject to IRB approval. Screenshots of the Sona study description page that students viewed for the present study are available in Appendix B (Students signed up for the behavioral and experimental appointments on separate Sona pages). Sona recruitment not only provided an easy way to target specific population demographics it also provides students with an easy-to-use computer/smart device-based study enrollment system.

Interested students can self-register for the study by selecting from the available dates and timeslots, after which the researcher is notified of the appointment booking. Subjects can sign-up for an available timeslot up to four-hours prior to the beginning of the time-block. Subjects can cancel their appointment via Sona up to one-hour prior to the beginning of the appointment time-block. In addition to using the graphic-user-interface (GUI) for appointment booking and cancelation, students can contact the researcher directly via email within the Sona system. Students that did not show up for their appointment and who had not canceled the appointment via Sona or contacted the researcher directly were logged as a "no-show" in the Sona system. Students who failed to keep their appointment but contacted the lab via email or phone were logged as

"excused" within the Sona system and were offered an alternate appointment date and time.

Despite Sona's ease-of-use for both the researcher and research participant, recruitment goals were not met. Due to Sona-credit use primarily within first- and second-year introductory psychology courses at USD most subjects recruited through Sona systems were between 18 and 19 years of age (n=21). Only two 30–35-year-old subjects were recruited through Sona despite four semesters of active Sona-based recruitment. In summary, Sona-based recruitment aided in the recruitment of the 18–19-year-old target population but did not help access the non-traditional student body or the graduate and professional school student bodies, which may have had members eligible for participation. A discussion of the future recruitment effort recommendations and potential explanations for poor subject recruitment in the present study is offered in chapter seven.

Compensation.

Compensation consisted of course credit or monetary compensation for each laboratory session (behavioral training and experimental testing) and entry into a drawing for a $400.00 gift card. This subsection will describe compensation amounts, when and how compensation was dispersed, and provide a statement of funding.

Subjects attending a course requiring research participation were compensated with 11 Sona credits at the conclusion of each session. A total of 22 Sona credits were earned for study completion. For a full description of the Sona system and Sona credit allotment see the Sona recruitment subsection above. There was no cost incurred by the researchers for use of the Sona system or allocation of Sona credits.

All subjects not requesting Sona credit were compensated at a rate of $20 per session, earning a total of $40 dollars for completing the study. Compensation was paid at the end of every session to ensure that subjects were properly compensated for their time if they decided to withdraw before the second session. Monetary compensation was paid in U.S. twenty-dollar bills withdrawn directly from a bank to ensure that no counterfeit money was included. A receipt book was kept for all money payments. Money and receipts were kept in a standard lockbox and stored under double lock when not in use.

In addition to monetary and Sona compensation, a $400 gift card drawing was added to improve recruitment numbers for the adult group. The gift card drawing was applied retroactively to all participants who completed the study prior to its implementation. All subjects who completed the full study (behavioral training and experimental testing) were eligible for entry into the gift card drawing. The gift card drawing was completed by generating a random number within a number-range using a customized Matlab script. Eligible subjects were numbered sequentially after ineligible subjects were removed. Odds of winning in the final drawing were 1/26. The gift card winner was notified via university email that two "multi-card" gift cards would arrive from *Blue Mountain E-cards* (https://www.bluemountain.com/). Gift cards were awarded on March 19, 2019 and verification of receipt was added to study documentation.

The addition of the gift card was intended to aid in recruitment of the adult group by compensating for the below average monetary compensation for participation in experimental neuroscience research. Standard compensation can range between $100 and $150 an hour. Because all monetary compensation was an out-of-pocket expense for the student PI, the standard rate was not feasible. However, it was believed the addition of a

lump $400 gift card (that amount would cover the full experiment for just one subject at the $100/hr. rate for two 90-minute sessions) would make-up for the low compensation rate while remaining within the student PI's budget.

Study locations.

Two study locations were used for behavioral training and experimental testing. The first study location was a neuroscience laboratory in Vermillion, South Dakota (USD, Sanford School of Medicine, Basic Biomedical Sciences) with a dedicated human subject testing area. This location served as the primary study location and was utilized throughout the study. Additionally, data storage and analysis took place at this location. The second study location was at the Sanford School of Medicine Sioux Falls (SD) campus in a dedicated research space.

The second location was approved at the end of December 2018. Recruiting and testing in Sioux Falls, SD between December 2018 and March 15, 2019 was intended to improve recruitment numbers for the 30–35-year-old population. Sioux Falls, SD is the largest urban area in the state of South Dakota with a reported population of 187,200 (City of Sioux Falls, 2019), whereas Vermillion, SD has an estimated population of 10,801 (United States Census Bureau, n.d). Vermillion, SD is located 63 miles south of Sioux Falls, SD. The convenience of a testing site in Sioux Falls was hoped to offset the low monetary compensation for non-Sona credit participants ($20/session), additionally the greater population numbers allowed for more recruitment opportunity. The addition of the second testing location resulted in three additional subjects in the 30–35-year-old age-group but did not result in meeting recruitment goals for this participant population.

Inclusion and Exclusion Criteria for Study Participation

Individuals that met the age restrictions were subject further to exclusion criteria. Exclusion criteria were listed on all recruitment flyers and on the Sona study description page. However, after a potential subject gave informed consent prescreening questionnaires were administered to ensure eligibility. The exclusion/inclusion criteria were developed to: (a) ensure that all members of an age cohort were within the same neuromaturational period (age & gender); (b) ensure that a participant could perform the behavioral and experimental tasks appropriately (visual acuity & language restriction); or (c) to reduce variance in group level data (handedness & medical history). The subsections that follow will describe the exclusion/inclusion decisions for all categories except age (explanation for selection of age groups can be found above). Only right-handed male subjects were admitted to the study.

Sex.

Sexual dimorphism in the human brain has been well studied over the past two decades (Koolschijn & Crone, 2013; Ritchie et al., 2018), as has dimorphic differences in maturational trajectories (Lenroot et al., 2007; Raznahan et al., 2010) between male and female phenotypes of brain development. As the sociologist David Franks noted, “[t]here was a time when some people argued that sex or gender differences in the human brain were nonexistent, but today the available data make such arguments very difficult” (2018, p 164).

However small, dimorphisms in structure and maturational trajectories are substantial enough that sex is recommended as a biological variable in all neuroscience research (Xin, Zhang, Tang, Yang, 2019), and especially research focused on brain

maturation (Lenroot, et al. 2007). Thus sex-matching—the exclusion of one sex or the creation of same sex comparison groups for each condition—is ideal (Lenroot, et al. 2007). Despite differences between male and female maturational trajectories (or structure), no reasonable argument has been presented for the trajectory (or morphology) of one phenotype (male-typic brain vs. female-typic brain) being conceptualized as normative and the other as a deviation. Therefore, sex-based inclusion/ exclusion decisions in neuroscience research must rely solely upon the research questions and phenomena of interest.

The present study was restricted to male subjects due to sexual dimorphisms in the human brain that lead to earlier completion of the adolescent maturational restructuring event in females vs. males (Ritchie et al., 2018). Additionally, the disproportionate levels of violent crimes committed by males vs. females (Bennett, Farrington, & Huesmann, 2005; McDonald, Navarrete, & Van Vugt, 2012; Niehoff, 2014) that could also be cross categorized as intergroup conflict or intergroup violence led the focus to fall on male subjects. Compelling observations have also been made for an age–crime curve (Hirschi & Gottfredson, 1983; Matthews & Minton, 2018) (at the macro level) that functions in an inverted-U—with a spike in crime during adolescence and a subsequent decrease in crime as a function of age thereafter—not unsurprisingly mappable to the inverted-U of human brain development. Female subjects included with the male subjects for the adolescent group would result in data that are difficult to interpret due to the mixture of data from brains that more closely resemble the adult group mixed in with the adolescent group's still maturing brains data.

Sex categorization for the present study was based upon biological sex and not upon gender identification. No study subjects reported a difference between biological sex and gender identification (transsexualism). However, a decision was in place to exclude transsexual subjects' (in this case, those who were biologically male but with a female gender identity) data from group level comparisons initially. Group-level event related brain potential data from transsexual participants and cisgender participants would have been analyzed separately and then in a combined sample to ensure that any variance introduced by the transsexual subjects is understood (if there were any variance at all).

Sexual identity is an extremely complex component of the self—one with genetic and neuromaturational components as well as cultural and societal components. Studies over the past decade have demonstrated that male-to-female (MtF) transgender adults exhibit cortical thickness patterns, white-matter microstructure patterns, and functional, task-related activation patterns that are like cisfemale controls but not cismale controls—termed a *feminized* brain (Mohammadi & Khaleghi, 2018). Mohammadi & Khaleghi (2018) also report neural changes to some regions in female-to-male transgenders but suggest that by-and-large the brains of FtM transgender individuals match that of the cisfemale controls in thickness and function. The etiology of neuro-developmental changes in the brain that lead to brains that match gender identity but not biological sex is a continued area of research and debate; arguments based on available evidence have been made for socially driven neuroplastic changes, while others have demonstrated roles for heritable genes and teratogens during sexual differentiation (Rosselli, 2017; Mohammadi & Khaleghi, 2018; McCarthy, 2019; Pereira et al., 2019). Whatever the etiology, the evidence is compelling for neuroanatomically sexually dimorphic brains that

do not match biological sex which will necessarily affect group level neuroimaging and electrophysiology data interpretation. Thus, more research is necessary on brain sexual dimorphism in cis- vs. trans-gendered individuals so that clear guidelines can be established for gendered grouping in fMRI and ERP research.

Handedness.

Only right-handed subjects were accepted for this study. The present study's exclusion of left-handed subjects follows accepted convention within cognitive neuroscience research. Left-handed subjects are excluded to reduce within-group, between-subject variance due to reverse lateralization of function in the brain (Williams et al., 2014). Lateralization of function refers to the hemisphere of the brain where specific functions are carried out. For example, language function is known to be "left-lateralized." According to Williams et al. left-lateralization of language function has been demonstrated in both right- and left-handed patients with aphasias (problems with production or comprehension of speech) (2014). However, the authors note that left-handed subjects in studies of lateralization of language function exhibited more variation in lateralization with approximately 30% of left-handed subjects being bi-lateral or right-lateralized—with similar results in studies of other lateralized functions (Williams et al., 2014). Therefore, the risk of reduced statistical sensitivity due to increased heterogeneity in the group level data due to lateralization does not justify the manifold benefits of including left-handed subjects at this stage of the investigation.

Handedness was assessed in two ways, self-report and a handedness inventory, during prescreening (see Appendix A; Demographics Questionnaire and Handedness). The demographics form contains questions regarding vision, gender, age, and

handedness. Additionally, the form contains a nine-item handedness inventory and a limited medical history. The form organization allows the researcher to ask the subject to identify their dominant hand and then ask other self-report questions before administering the handedness inventory. It is important to obscure the purpose of the handedness inventory until its completion to prevent demand characteristics from altering subject performance. The handedness inventory used for prescreening in this study was a nine-item inventory. Each item on the inventory was a culturally relevant task that the participant was asked to mime. The nine items were:

- Throw a ball
- Brush teeth
- Eat soup
- Comb hair
- Swing a hockey stick
- Swing a racquet
- Hammer a nail
- Point to something
- Write your name

The researcher could circle L or R in response to the subject action. Following the inventory, the subject was asked: is there anything that you do with your left hand? Based upon the inventory and subject self-report information a decision was made regarding handedness. Because the inclusion/exclusion criteria were prominently displayed on all study subject recruitment material no subjects were dismissed due to handedness. However, the handedness inventory remains an important tool beyond informative

advertising and self-report. For example, in many myth traditions the left hand came to have an evil association, which in turn led to forced handedness-conversions (e.g., the Catholic school system in the U.S.A.) (Masud & Ajmal, 2012). Potential subjects who have undergone forced sinister-to-dexter handedness-conversion may view themselves as "right-handed people," however, when asked to mime the inventory behaviors, these individuals will revert to their left hand for most items.

Medical history.

Medical history items on the demographics form (Appendix A) were limited to events, behaviors, and medications that alter brain function. Alteration of brain function introduces variance into the EEG data such that it becomes difficult to interpret. As a result, subjects with the following histories were excluded:

- Traumatic brain injury
- Learning disability or attention deficit hyperactivity disorder
- Alcohol/drug abuse or dependence
- Neurological conditions
- Psychiatric conditions
- Taking medicines such as those to treat seizures, sedatives, tranquilizers, barbiturates, or any psychoactive medication (medications that alter brain function).

Medical prescreening for study eligibility was based solely upon subject self-report. No access was requested for subject medical or psychiatric treatment records or current medication lists.

English language ability.

Due to the nature of the behavioral and experimental tasks, subjects were required to read and write in English. At various points during the study, subjects were required to write political reflections or make complex decisions based upon text that they read, and information that they believed about a person pictured. Subjects English language ability was covertly assessed during the informed consent and demographics questionnaire process.

Visual acuity.

Visual acuity questions on the demographics form (Appendix A) asked if the subject's vision was normal or corrected-to-normal. If the subject's vision was corrected-to-normal an additional question asked whether the subject wore glasses, contacts, or both. Visual acuity information served two purposes. First, visual acuity responses allowed the researcher to assess whether the subject would be able to perform the behavioral tasks and experimental tasks. Second, if a subject had corrected-to-normal vision understanding the method of correction (glasses and/or contacts) allowed the researcher to adjust the equipment set-up during experimental testing to accommodate for glasses. Accommodation of set-up included adjustment of steps during EEG cap set-up and a decision process for the collection of eye-tracking data. Eye-tracking data were collected on subjects with normal vision or those with low-reflectance contacts. While the eye-tracking goggles were able to fit over most eye-glasses frames, the combination of an anti-glare lens on the eye-tracking goggles and the reflectance of the subject's eyeglasses prevented pupil localization and pupil diameter measurement. As a result, eye-

tracking data were not collected on these subjects and this change to the set-up procedure required preplanning. Eye-tracking data were not used for the present study.

Ethics Statement

All experimental procedures received approval from the Biomedical Institutional Review Board of the University of South Dakota (USD; Vermillion, SD). Additionally, an authorization agreement was established between the South Dakota State University (Brookings, SD) IRB and the USD IRB deferring to the USD IRB. An additional authorization agreement was established between the Augustana University IRB and the USD IRB, deferring to the USD IRB. No subject recruitment, behavioral testing, or experimental testing was conducted at Augustana University (AU; Sioux Falls, SD). The authorization agreement between AU and USD was due to researcher employment as a visiting professor between August 2016 and December 2018. No conflicts of interest are reported.

Subjects, Subject Demographics, and Removal Decisions

Subjects and subject demographics.

Subjects were 28 right-handed males between the ages of 18–19-years-of-age (n=23) or between the ages of 30–35-years-of-age (n=5). The racial demographics for the combined groups was: (a) White = 23; (b) Asian = 2; (c) Black = 1; (d) Hispanic = 1; (e) Mixed Race = 1. Race/ethnicity was self-report. Aside from providing a general understanding of where data are coming from, a secondary purpose for collecting this demographic information was to allow for future analysis of same race vs. other race effects on ERP components of interest.

Subject removal decisions.

Several subjects and/or subjects' data were ultimately removed during the testing and analysis phases of the study. During the testing phase, subjects could be removed from the study for failing to follow researcher instructions or if the researcher felt that a risk was posed to the subject. From the 18–19-year-old (adolescent) group, one subject was removed for failing to follow study instructions. No subjects were removed from the 30–35-year-old (adult) group for failing to follow study instructions.

During data analysis, several subjects' EEG and ERP data were excluded. Exclusion during data analysis occurred because of excessive artifact and equipment malfunction. Excessive artifact is non-brain electrical activity, such as muscle activity or "noise," that dominates the EEG trace, thereby obscuring the data. If the non-brain activity is such that the EEG cannot be interpreted after filtering or most of the epochs will be removed the artifact is deemed excessive and the data are excluded under the dictum garbage-in-garbage-out (GIGO). Excessive artifact required the removal of one subject's data from the adult group and three subjects' data from the adolescent group. Additionally, one subject's data from the adult group was removed due to equipment failure which resulted in an inability to record from the F4, C4, P4 electrodes. Finally, one subject's data from the adolescent group was excluded from analysis for exceeding an *a priori* mean artifact detection threshold (removed trials = .45).

The final sample size for the present study was n=16 for the adolescent group and n=3 for the adult group. While these numbers are far below the anticipated recruitment numbers, the data the subjects provided offer insight into key differences that may exist

between adolescents and adults in social cognition and offer piolet data for more robust future investigations of sex, age, and intergroup processing.

Apparatus and Stimuli

Apparatus.

Electroencephalography.

For this study, the BIOPAC MP150 (Biopac Systems, Inc, California, USA) data acquisition hardware and AcqKnowledge software were used for electrophysiological data. Recordings were obtained from nine electrode sites (F3, Fz, F4; C3, Cz, C4; P3, Pz, P4) following the international 10-20 montage for electrode placement (American Encephalographic Society, 1994; *see figure 1*). EEG activity was sampled at a frequency of 1000 Hz, and filtered online so that non-physiological signals below .1 Hz and above 35 Hz were attenuated.

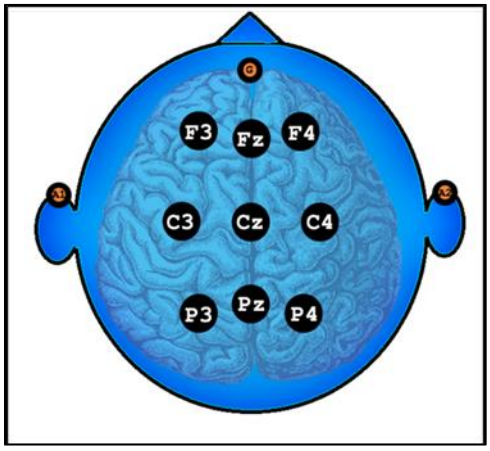


Figure 5: International 10-20 montage with electrode sites indicated for the present study. A1 and A2 represent linked mastoid electrodes on left and right earlobes. G represents the ground electrode.

Tin (Sn) electrodes were recessed and prepositioned in a lycra-type fabric electrode cap (CAP100C, Biopac Systems, Inc, California, USA). Electrodes were referenced online to linked mastoids at the right and left earlobes and grounded by a midfrontal electrode. Vertical and horizontal electrooculography (VEOG and HEOG) electrodes (Ag-AgCl) were placed superior and lateral at the right eye. All electrodes were wet. Electro-gel (Biopac Systems, Inc, California, USA) was applied at F3, Fz, F4; C3, Cz, C4; P3, Pz, P4 and both mastoid electrode sites. SIGNAGEL (Parker Laboratories, Inc., New Jersey, USA) was applied directly to EOG electrodes prior to placement. Prior to gel placement, face and earlobe sites were prepped with NuPrep skin prep gel (Weaver and Company, Colorado, USA) and sterile alcohol swabs. EEG electrode recording sites were lightly abraded with a blunted needle to remove dead skin cells. Abrading procedures are designed to lower impedance.

Serial response box.

A serial response box (SRBox; Psychology Software Tools, Sharpsburg PA) was used during behavioral training and experimental testing. The SRBox for this study (see Figure 6 below) utilized the left-most buttons (labeled Yes and No respectively). The remaining right most buttons were obscured with medical tape and button presses were disabled in EPrime (Psychology Software Tools, Sharpsburg PA). Disabled buttons were non-functional and would not register as a button press during the experimental task. During behavioral training, subjects used the SRBox for a memory game which was designed to give instant feedback on memory for group members and give pre-experimental-testing training on the device. During experimental testing, subjects used the prelabeled buttons to indicate the likelihood that an ingroup or outgroup member pictured

made the statement (or holds the position) appended to the picture in text form (see Figure 9).

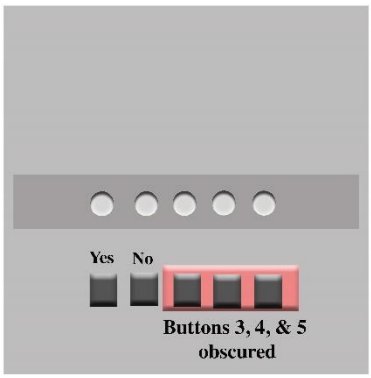


Figure 6: Cartoon depiction of the SRBox used in the present study with Yes/No labeling indicated. Buttons highlighted in red were obscured with medical tape and disabled (button presses from buttons 3,4, & 5 were not registered).

Photodetector circuit.

A custom photodetector circuit was used to detect and record stimuli and fixation onset and latency. The photodetector circuit was mounted to the upper right corner of the CRT monitor and consists of a photodiode (6mm silicon pensive photodiode window) and a custom circuit board (ExpressPCB, https://www.expresspcb.com). The circuit board is 25 x 44 mm and uses two integrated circuits (TLC2262 operational amplifier and 74HC14 CMOS Schmitt trigger) and CMOS logic output.

The photodetector circuit was used as a direct input into the BIOPAC MP150 system. Ensuring that fixation and stimulus events are distinct enough in luminance levels, the photodetector input allows for increased precision in flagging the onset and offset of stimulus events. As shown in Figure 9, the present study used a black background and white fixation cross to contrast with the white background of the stimulus images.

Luminance contrast is only necessary for the area directly covered by the photodiode, however, because consistent placement of the diode would require a luminance area larger than the diode area, a solid background avoids the possibility of creating an unintended flanker that might distract participants from the experimental task. Small distractions were of considerable concern due to the complex nature of the experimental task and the relatively short time with which to complete it.

Stimulus presentation apparatus.

Stimuli were presented on a 45.5 cm [17.9 in] CRT monitor (Sony Trinitron Multiscan G400) running at 85 Hz. Stimulus presentation and data acquisition were driven by a Hewlett Packard PC (Hewlett-Packard Development Co., Palo Alto, CA) with an Intel ® Core™ i5-2400 CPU @ 3.10 GHz, 3101 MHz, 4 Core processor and 64-bit Operating System. The CRT monitor was placed along the midline of a large work surface, centered approximately 50 cm in front of the seated subject (visual angle of 39.96˚ horizontal and 30.88˚ vertical). A custom EPrime (Psychology Software Tools, Sharpsburg PA) program was used to present stimuli in random order and at predetermined time-intervals.

Stimuli.

Raw images.

Forty-eight novel stimulus images were used for this study. Images were headshots of individuals from four racial/ ethnic categories (White; Black; Asian; & Hispanic) and two age categories (young & old). Images were digital photographs of faces with a neutral expression; all images were equated in mean luminance. Images were courtesy of Michael J. Tarr, Center for the Neural Basis of Cognition and Department of Psychology, Carnegie Mellon University (http://www.tarrlab.org/); image acquisition and

dissemination by the Tarr lab was funded by NSF award 0339122. Racial/ ethnic categories were pre-designated by the Tarr lab. Young versus old distinctions were a subjective assessment; images were selected that appeared to be of individuals either between 18–19-years-of-age or between 30–35-years-of-age. However, actual age or age bracket of individuals pictured is not known.

The 48 novel images were divided into three groups of 16 images. Each group of 16 images consisted of an equal distribution of age, race/ ethnicity, and sex categories (see Table 4). Distribution of categories was not equated to local or regional proportions in order to maintain internal validity during group level analysis of ERP data investigating the effects of one or more of the independent variables on the dependent variables. Proportional representation would necessarily decrease internal validity by introducing practice effects and anticipatory artifact for the most frequently appearing images (*see* Woodman, 2010). Anticipatory artifact is a well-known confound in ERP research wherein the subject elicits a neural response in anticipation of a common or temporally predictable stimulus. The anticipatory neural response obscures early components and does not allow for appropriate interpretation of the subject response. As a result the overall result for a two-way interaction—say ingroup/congruent, where the subject views an image of an ingroup member with a congruent statement below it (congruency is based on the subject's political leaning)—would not reflect the neurological response to ingroup members overall but would now reflect a neurological response to a particular racial category. This effect would be true for all four conditions (ingroup/ congruent; ingroup/ incongruent; outgroup/ congruent; outgroup/incongruent). However, with the current design custom Matlab (MATLAB and Statistics Toolbox

Release 2012b, The MathWorks, Inc., Natick, Massachusetts, United States) code was developed to isolate race, age, and gender effects during additional analysis outside of the scope of the current project.

Table 4.
Image Variables for All Image Groups

Race / Ethnicity	Age	Sex
White	Young	Female
		Male
	Old	Female
		Male
Black	Young	Female
		Male
	Old	Female
		Male
Asian	Young	Female
		Male
	Old	Female
		Male
Hispanic	Young	Female
		Male
	Old	Female
		Male

Note. 50% of all images were female; 50% were male; 50% were young; 50% were old; and each race/ ethnicity was represented with 25% of the images. Each image group was comprised of the same percentages for image variables.

The three image groups were: (a) the Bears group; (b) the Lions group; and (c) an unnamed outgroup. The Bears group was the ingroup for all study subjects. The Lions group was the outgroup for all study subjects during experimental testing. The unnamed outgroup images served as outgroup/non-group members within the group-member memory games during behavioral training. Subjects viewed the raw Bears images during memorization tasks and the memory games and viewed the raw unnamed outgroup images during the memory games. The addition of an unnamed outgroup for the memory games during behavioral training was to provide subjects with a recognition task similar to the experimental task (for image recognition) without introducing practice effects for an outgroup or causing the subjects to confuse outgroup and ingroup members. Confusion between groups was a concern because of the short intersession intervals and limited time spent memorizing ingroup members. Furthermore, the addition of the

unnamed outgroup resulted in an experimental testing environment that better mimicked real-world ingroup vs outgroup processing—namely more time, cognitive resources, and nuance applied to ingroup members and more heuristic-based assessments applied to outgroup members. Because all the images were novel to the subjects at the start of the study, equal time learning group members for each group would have eliminated this effect. Bears images and Lions images were also further processed for experimental testing.

Experimental images.

Bear and Lion group images were processed for experimental testing. All images from each group were placed within a custom template that contained: (a) the image; (b) group logos; and (c) a political statement. Stimuli were created in Adobe Photoshop (v. CS6). Stimuli were created on a 20” x 20” white canvas. Bear and Lion group logos in the upper left and right corners of the background layer (respectively). Logos were decreased in opacity (58%) to minimize distraction. A black rectangle layer was centered on the background layer and the group image was added to the black rectangle layer. The image was positioned so that a larger portion of the black rectangle background would extend below the image to accommodate text; the positioning created a “border” appearance around the remainder of the image. Below the image, on the extended black background, a stereotypically conservative or liberal statement or position was typed in white lettering (Dyslexie font, 48 pt., #fffefe) (see Figure 7 for a sample stimulus).

Figure 7. Sample stimulus image.

Each image was used twice—once with a conservative statement and once with a liberal statement. Thus, subjects saw each image with both conservative and liberal statements. Furthermore, corollary statements or positions were used for the two versions of the stimulus. For example, if image A had beneath it "pro-choice," it (image A) would be seen again with "pro-life" underneath it. This allowed for manipulation checks to be run on image and statement. Additionally, this design allowed the researcher to determine performance levels for each participant (i.e., whether they recognized their group members at above chance levels). Another benefit to the design is the built-in flexibility.

Because the experiment used notional groups—groups that were not real but that the subjects perceived to be real—there needed to be a way to match the ingroup to the subject's political leaning while still holding "group" constant across subjects. Taking the ingroup Bear images as an example: by creating two stimuli with the same image but corollary political statements, whichever one aligns with the subject's political leaning becomes the ingroup/ congruent stimulus and whichever one does not align with the subject's political leaning becomes the ingroup/incongruent image. When creating an experiment in EPrime the researcher can indicate variable values, e.g., whether a stimulus is conservative, the image group (Bears or Lions), race, gender, etc. After each

experiment EPrime provides a text file with the order of stimulus presentation, the qualities of each stimulus (determined by the researcher), response selection, and reaction times. Custom Matlab code is then used to read the EPrime text file and create coded event markers on the raw EEG .set file in EEGLab. Thus, the qualities of each image become unimportant in lieu of the variable levels of interest.

Stereotype phrases for stimuli were created for the experimental stimuli using information presented as stereotypes for political-liberals and -conservatives as a part of a summer 2017 social problems course (Soc 205) offered at Eastern Oregon University by sociology professor Bill Grigsby (https://people.eou.edu/socprob/readings/week-2/liberal-vs-conservative/). Professor Grigsby was not consulted or contacted for the creation of the stereotype stimuli listings. Phrases were positively worded to account for confounds due to mixed wording styles. For example, “Supports Limited Government” “Supports Large Government.” The political areas covered by the phrases appended to the stimulus images included the environment, war, poverty, government (role of), crime, and morality.

Procedure

Overview of the procedure.

The present study required subjects to complete two 90-minute laboratory sessions. The first session involved (a) prescreening and intake, (b) behavioral training, and (c) scheduling for session two. A detailed description of the behavioral training protocol is found below, and a visual representation of the behavioral training timeline is provided in Figure 8. The second session involved (a) reconsenting the subject, (b) experimental testing, and (c) exit protocol, which included an end-of-study survey and

deception debriefing with reconsent. Figure 9 is provided as a visual guide to the experimental task, stimulus presentation, and apparatus used by the subject. The mean interval between behavioral training and experimental testing was three days (*SD* = 2). For both sessions and both research locations subjects were met by the researcher in a predesignated common area located in the research facilities before being escorted to the testing space. At the beginning of each session subjects were required to give informed consent to continue their participation, and no study-related questions were asked prior to consent. At the conclusion of experimental testing subjects were provided a deception debriefing and were re-consented for continued use of their data. The prescreening, intake, exit, and deception debrief forms are provided in appendix A.

Deception condition statement.

The present study used deception in (a) recruiting advertisements, (b) descriptions of the nature of the study (e.g. what phenomena was under investigation), and (c) explanations for grouping procedures, the physical reality of the groups, and the nature and purpose of behavioral training and experimental tasks. Deception was necessary due to the sensitive nature of intergroup bias research and the demonstrated tendencies of subjects to attempt to alter responses in a socially desirable way, thereby introducing bias into the data (Korn, 1997).

The use of deception also facilitated incorporation of "notional groups" in the present research. Notional groups are fictitious groups that, from the perspective of the subject, have the qualities of a real group. The use of notional groups in the present study allowed for a reduction of variance by ensuring that all subjects' "group-mates" were the same and all outgroup members were the same. However, to enhance believability,

deceptive comments periodically made throughout training and experimentation were required. For example, the researcher would explain to the subject that it was necessary to not disclose a person's participation in the study if they encountered their photograph in the ingroup or outgroup photo arrays. During deception debriefing, multiple subjects commented on (a) believing that they recognized a group member in a public place and (b) that the fine details made the deception believable. The last point is important because the ethnic diversity of the stimuli groups was incongruent with the dominant-homogenous (White-European) population. Furthermore, initial uncertainty was dispelled with the above mentioned tactics and by proffering that the present study was "one arm" of a multi-site, multi-state study (research in urbanized areas of SD was emphasized due to the larger diversity profile and plausibility of an individual from those areas visiting a location near the testing site).

As a reminder the photographs used for the groups were provided by the Tarr lab (Carnegie Mellon) and not of individuals in the south-eastern South Dakota region. It should be noted that many of the many of the 18–19-year-old subjects were completing course credit for introductory psychology courses and appeared primed to uncover deception in research, or at the very least to try to figure out what the researcher was looking for. Despite subject curiosity, end-of-study comments revealed that the deception was effective.

In addition to notional groups, deception was used for recruiting and executing the study. Subjects, enrolled in, and completed the study under the false premise that they were enrolled in a study investigating differences in memory and evaluation between age groups. Specifically, differences in memory function and cognitive load in an older

population (each age group was told that they were some degree of control group). By describing the task without mentioning the construct of interest (intergroup bias) the research design validity was further protected. It is a well-established phenomenon that some portion of research subjects will alter behavior and task performance on stereotype-related tasks because of societal social judgement embodied by the researcher (Peterson et al., 2011; Bäckström & Björklund, 2013; Anderson, 2019). In order to further reduce the likelihood of modified behaviors, subjects were explicitly told that the political portions of the experiment were in place simply as a grouping mechanism. For a critical examination of the use of deception, reasons for deception, and potential impacts on subjects from sociological and psychological points of view see Hertwig and Ortmann (2008).

In part, use of political orientation as the grouping variable was unrelated to the study, insofar as any salient ingroups vs. outgroups should produce the same neurological responses in ERPs indexing areas associated with the SBN in the same subjects. The selection of political orientation is owed to its broad applicability (many have an opinion on individual issues), the availability of associated items (e.g., initiation audio), and widely available and well established stereotypes that are also low on the "personal offense scale" (than stereotypes for religious issues might be).

Lastly, under the deception condition a passive listening task and a two-minute free-write task were implemented to further facilitate ingroup liking and memory for group members through non-noxious initiation and priming. However, subjects were told that the listening task was to give them a number of recent political ideas to consider and that the free-write is used by the researcher to derive the statements that appear below

each image on the experimental task (subjects were also told that those statements could be verbal utterances as well).

Behavioral training.

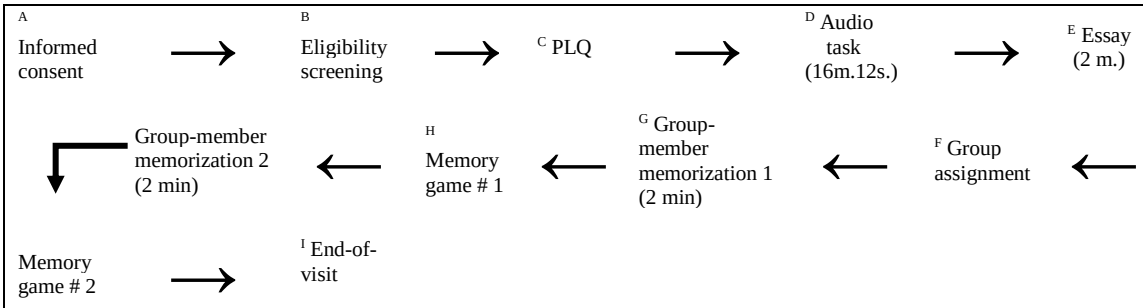


Figure 8. Visual summary of the behavioral training protocol. [A] Informed consent is given under a deception condition. Participants are reconsented following the experimental task at visit two. [B] Eligibility screening included medical history, age, gender, & handedness. [C] The PLQ was a two-part political leanings questionnaire. [D] Subjects passively listened to the Trump presidential inaugural address. [E] Following the audio, subjects were given a blank sheet of paper and two minutes to write their thoughts as they reflected on the inaugural address. [F] Subjects were then placed into their group. Every subject was placed into the "Bears" group. [G] For each group memorization task subjects viewed headshots of "group members" presented two at a time on a PowerPoint presentation. [H] The memory game (completed twice; once after each memorization task) used the experimental task station and button box and provided the subject with instant performance feedback. [I] At the end of the visit the subject had their photograph taken (maintenance of deception), was compensated for their time, and scheduled their follow-up appointment for the experimental task. Total time allotted for behavioral training was 90 minutes. Average time for session was 60 minutes.

2017 Social and Economic Political Leanings Questionnaire (PLQ).

The first study-related activity performed by a subject following consent and prescreening was the 2017 Social and Economic Political Leanings Questionnaire (PLQ) (Appendix A). The PLQ was a two-sided questionnaire divided into two parts. Side one was titled "self-identification" and contained eight self-report questions covering political party affiliation and past political actives. The self-identification questions on side one was created by the researcher for the purpose of the study. Data obtained from side one was limited to political affiliation, which was used during data analysis to create event codes for the EEG files. Side two was titled "issues inventory" and was the 12-item *Social and Economic Conservativism Scale* (SECS; Everett, 2013). Side two did not reference the SECS, Everett, or the true nature of the scale to reduce the likelihood of social desirability responding. Information obtained on side one of the PLQ could easily

have been obtained verbally or as a single question on the initial study demographics form. The presence of side one was primarily to obscure the true nature of the SECS on side two by providing a logical flow and a cover story.

Subjects were told that the study was uninterested in politics and political orientations, but that political orientation (leaning) is an easy and fast way to place subjects into groups. Subjects were also told that every effort was made to place them in a group with individuals who have answered most similarly to themselves on the PLQ. Subjects were told that the "issues inventory" added appropriate levels of nuance to facilitate meaningful group assignments. Subjects were further told that appropriate group placement was vital to successful performance on testing day and as a result open and honest responding was essential on all political leanings paperwork. To that end, questions were encouraged if an unfamiliar word or concept was encountered.

As a task, completing the SECS served as a self-prime by requiring the subject to rate their overall positivity or negativity on a scale of 0 to 100 with 50 indicating neutrality. This study used a continuous scale for the SECS—the SECS has been validated with continuous and incremental applications—, thus allowing each subject maximal individuality when identifying their position on issues. Additionally, the instructions and task, along with researcher comments, laid the foundation for subject buy-in on the grouping procedure and the groups themselves. Because the groups subjects believed they were being placed in were notional and true groups were natural (age), the PLQ was not used for any grouping decisions.

Passive listening task and free-write task.

Following completion of the PLQ subjects were told that they would passively listen to a political speech. Subjects were given no information about the content of the speech or information about the speaker prior to hearing the audio file. The political speech consisted of Donald J. Trump's presidential inaugural address (16 m 12 s ; mp3) played on a laboratory computer. Subjects were seated away from a desktop and distracting items; a curtain prevented the subject from viewing the computer screen where the audio file was playing. Subjects were not given an initial reason for the task. Subjects were told that during the listening task the researcher would score their PLQ sheet and enter those scores into a program that would place them into a group with members who answered most closely to them. Subjects were further told that multiple laboratories were working on "aspects of the study" and grouping would be across study regions. As mentioned previously, this was a preemptive deception-line used to reduce suspicion when subjects later encountered the diverse nature of their group memberships and was deemed necessary due to the largely homogenous nature of the population found in the study region. Lastly, during the listening task, the researcher moved to a computer station outside of the immediate field of view of the subject but in a position to monitor subject behavior while scoring the "political leanings questionnaire" and attending to subject-specific administrative tasks.

At the conclusion of the MP3 audio file, subjects began the free-write task with a blank sheet of paper with the current date and their subject-ID in the upper left corner. Subjects had two-minutes to reflect on any aspect of the speech, speaker, or concepts described in the speech that they chose. Subjects were told that they would be able to

complete an incomplete thought or a short sentence if cut off by the timer-buzzer. If the purpose of the listening and writing tasks were requested, subjects were told that the writing task helped the researcher better understand their political leaning if two potential groups looked like a good fit and more information was needed to model a "best-fit." Subjects were further told that some statements from the writing task may be used with their image in the experimental session for future participants, but that there was an equal chance verbal statements would be chosen. The true nature of the listening and writing task was that both served in the deception as a non-noxious initiation to facilitate ingroup liking and memory for ingroup members (Aronson & Mills, 1959).

Group assignment, group memorization and memory-for-group game.

Once the two-minute free-write time ended, subjects were led to a laboratory computer where their group assignment decision was displayed (loaded by the researcher during the free-write). All subjects saw a screen that read "*Congratulations you're a Bear!*" As a reminder, the study used three groups. The first group, Bears, served as the ingroup for all subjects. The second group was an unnamed outgroup used for memory testing during behavioral training. The third group, Lions, served as the outgroup during experimental testing. Subjects were told that all groups have animal names "because the researcher is a dad," but the Lions were not mentioned during behavioral training.

The Bears group, or ingroup, took on whatever political leaning the subject held. Thus, if subject A was a conservative the Bears group was conservative collectively. If subject B was liberal the Bears group was liberal. To learn ingroup members, subjects participated in two rounds of memory tasks that consisted of passive memorization followed by an active "memory game." During the passive memorization, subjects were

given two minutes to review a PowerPoint presentation with headshots of their 16 group-mates arraigned two-to-a-slide. At the end of the two-minute passive memorization time, subjects were moved to a CRT monitor and positioned in front of a SRBox for the "memory game."

For the "memory game" a custom EPrime program was designed to randomly present the 16 ingroup images and the 16 training outgroup images (i.e., not the Lions' images). This task allowed the subjects and the researcher to assess memorization for the group members as well as provide training on the SRBox prior to experimental testing at the testing station. The task began after subjects read an instruction screen displayed on the monitor and then pressed any button on the SRBox to advance to the task. Following each image presentation, subjects were required to indicate whether the image was of an ingroup member or not by selecting buttons on the SRBox labeled yes or no (see Figure 6). Immediate feedback was given for each selection. If a subject made a correct response the text "correct" would flash in green ink on the top center of the screen. If the response was not correct the text "incorrect" would appear in red ink in the same manner. However, many subjects reported not noticing the feedback banner on the first round (until it was described to them). The memory game was not timed, and data were not recorded. Once the final memory game round ended (2 of 2) subjects were asked to gather their belongings and were directed to a nearby table for end-of-visit administrative tasks.

End-of-visit protocol.

The final memory game was the last task of behavioral training; however, subjects were retained for photographing, scheduling, and compensation. First head-shot

photographs were taken of each subject against a curtain backdrop; subjects were instructed to maintain a neutral expression. Photographs were framed to mimic the Tarr lab photographs used in the study design. Subjects were shown their photographs and were told that they would be added to their group, but that photos are added on a three-week cycle. Photographs were taken to enhance the deception and were deleted immediately after the subject left the research area. Following the photograph, subjects scheduled a date and time for their experimental testing and were compensated for their time with either Sona credit or cash ($20). Subjects were then thanked for their time and escorted back to the building common area. During the end-of-visit procedure, subjects were told that they could ask any questions that they might have about the experimental testing session. Additionally, subjects were given access to more direct communication lines (vs. the scheduling service) to the lab, student P.I., and P.I.

Experimental testing.

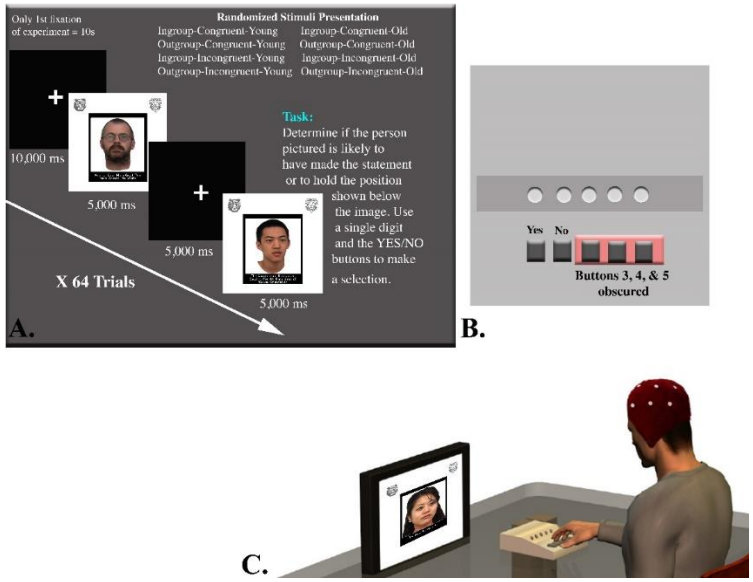


Figure 9. Graphic depiction of the experimental task. Except for the initial fixation period, fixation and stimuli present for 5,000 ms each. (A) Fixation appears between each stimulus presentation. Stimuli are randomly presented. A total of 64 stimulus trials are viewed by each participant. Fixation backgrounds are black with a white fixation cross to allow for a luminance-based distinction to be made between fixation and stimulus using a custom photo diode; (B) Subjects use the *Serial Response Box* to complete task. Medical tape was used to obscure buttons not in use. Additionally, buttons not in use were disabled; (C) This cartoon shows an approximation of the experimental set-up. During the experimental task subjects are seated in front of a table with a computer monitor and the SR Box. Subjects used their right index finger to complete button presses.

Informed consent, review of task instructions, review of group members.

Upon arrival for their scheduled experimental testing session, subjects were led from a common area in the research facility to the secured research area by the researcher who immediately reconsented the subject with same version of the informed consent document used at the beginning of behavioral training. After the subjects gave consent for continued participation, they were led to a computer desktop where they viewed a short PowerPoint presentation that reviewed the EEG instructions, task instructions, and importance of remaining still during EEG recording. Subjects advanced the slides at their

own pace. After subjects completed the presentation, they were given approximately one minute to review their group members before moving to the testing station to begin EEG set-up procedures. Subjects were told that the other group they would be evaluating (in addition to their own) would be the Lions, and that this group was directly opposite in political leaning to the Bears. Further subjects were told that when completing the task because they were so well matched with their group-mates on political issues they should self-reference; for outgroup members they "should think about what people opposite to them politically believe."

Equipment set-up and functionality tests.

Prior to setup, subjects were given an opportunity to use the bathroom and store any baggy overshirts (hoodies), hats, and/or uncomfortable or distracting items (car keys or cell phones). Once subjects were situated, equipment setup began by placing a retaining strap at chest-height; the strap had buttons for the EEG cap (to prevent movement) located centrally over the chest and a Velcro closure on the subjects' upper-back. Next electrodes were placed at the right eye and bilateral earlobe sites, and the EEG cap was placed and secured following the procedure outlined previously. Following EEG cap placement, subjects without glasses had eye-tracking goggles placed over the cap (eye-tracking data are not reported). Hardware and software associated with EEG and pupillometry acquisition were brought online and eye-tracking goggles were calibrated. Subjects then ensured comfortable positioning of the SRBox for sustained use during the task. Once subjects indicated that they were ready to begin the task, the researcher began EEG acquisition and instructed the subject to complete a series of jaw-clenches and eye-blinks to illustrate the need to remain still and control blinks and clenches as best as

possible during trials. Average time for setup was 20 minutes. After the demonstration, the EPrime experiment file was loaded and a welcome/instruction screen was displayed to subjects on the CRT monitor.

Experimental task.

After reading the task instructions the subjects were able to advance to the experiment by pushing any button on the SRBox (either yes or no). The experimental task began for all subjects with 10,000 ms of fixation. The initial fixation block was double the duration of the intertrial fixation blocks to allow subjects a chance to become comfortable with the environment. Following the initial fixation block subjects viewed the first image-statement pairing of the total 64 stimulus trials, which were presented randomly. Image-statement pairings consisted of a group member image (ingroup or outgroup) and a political statement or position (stereotypically conservative or liberal). Stimuli also included logos for the Bears group (ingroup) and the Lions group (outgroup) (see figure). Stimuli were presented for 5,000 ms and were followed by fixation (5,000 ms); advancement of stimuli was based on timing and not subject response.

As a reminder each group had 16 “members” and the Bears group was the ingroup and the Lions group was the outgroup. Over the course of the experiment, subjects saw each image twice, once with a conservative statement and once with a liberal statement. Thus, 32 images were ingroup images and 32 images were outgroup images. Fifty-percent of image-statement pairings were congruent and 50% were incongruent.

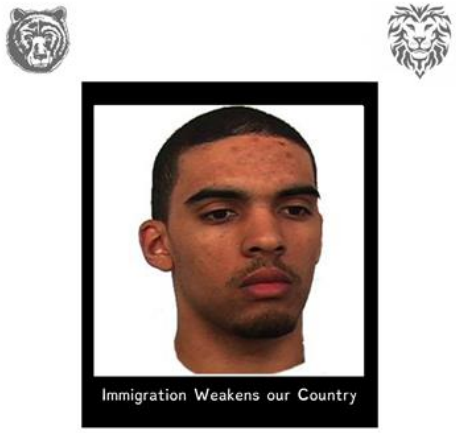


Figure 10. Opposing image-statement pairings for a Bears group image. Liberal-stereotype pairing is on left and Conservative-stereotype pairing is on right. This setup allowed for greater experimental flexibility, as well as more nuanced manipulation checks on image, race, and statement effects.

Congruency was initially in the mind of the subject. In other words, the subject sees each image twice, once with each type of statement and will mentally assign congruency. Experimentally, congruency was determined post-hoc using each subject's PLQ and an EPrime text file for each experiment that described the order of stimulus presentation. Together, this information was read into custom MATLAB script that then coded and recorded each event on the subject's raw EEG file for further processing.

The experimental task was to indicate if it is likely that the person pictured made the statement or holds the position that is written below the image. If the subject believes that it is likely that the person pictured would hold the position or make the statement listed below the yes button on the SRBox is pressed. However, if the subject does not believe that the picture and statement are congruent, the no button on the SRBox is pressed. All SRBox button-presses are made with the right index finger, and recorded

responses are those that occur within the 5,000 ms trial time. While the task may appear simple enough, it is deceptively difficult. In the five seconds allotted to subjects they must determine if the person belongs to their group, self-reference or activate an outgroup stereotype to answer the likelihood question, and then provide a motor response.

End-of-visit protocol.

After the final trial an end-of-experiment screen displayed instructing the subject to remain seated until further notice. All data files were saved and backed-up prior to removing equipment from the subject. Once files were saved, equipment was removed from subjects and an opportunity to use cleansing wipes to remove electrode gel and grease pencil marks was given. Total experimental session time ranged from 1 hour to 1 hour and 30 minutes. Following clean-up, subjects began the exit interview and deception debriefing.

Upon the conclusion of each subject's full study participation, the subject was given an exit questionnaire asking questions related to their general levels of comfort throughout the duration of their study participation. While deception is often necessary to ensure the validity of findings, use of deception can raise ethical concerns directly related to the validity of consent obtained under deception (Miller & Kaptchuk, 2008). Therefore, immediately following the exit questionnaire, subjects were fully debriefed to the deception condition. After the full nature of the study was explained, subjects were reconsented and subjects had the option to withdraw their data from the study without penalty or loss of compensation. All subjects gave permission for continued use of their data. Subjects were then given extended time to ask any additional questions about the study. This phase was also helpful in serving as a gage for the success of the deception

(i.e., did the subjects think the groups were real, did anything seem “fishy”). Subjects were asked to maintain the deception when discussing the study to others due to the small population size where the study was conducted. No subjects reported psychological distress as a result of the debriefing. Subjects were compensated for their final session and given instructions regarding the gift-card drawing.

Chapter Five: Data Analysis

To maintain chronological flow chapter five is divided into behavioral training and experimental testing subsections. The chapter begins with an overview of the scoring procedure of the Social and Economic Conservativism Scale (SECS) used for grouping, EEG event label creation, and as a part of the overall deception condition. Because subject performance on the SECS is not included as reported data, but interesting trends emerged that are referenced in the dissertation discussion, tables are presented with scale and subscale mean performance for each participant that completed the SECS. No further analysis is completed or reported on SECS data. Therefore, no complimentary section exists for the SECS in the results chapter.

The experimental testing subsection begins by providing details for the EEG and ERP preprocessing and processing pipelines developed by the student P.I. Next, the ERP analysis procedures, subject and data removal decisions, and ERP measurement procedures are described. Lastly, a discussion of the jackknife approach for unequal sample sizes is given, as well as, a discussion of mathematical constraints on hypothesis testing, and the details of the present study's statistical testing procedure.

Behavioral Training

12-Item Social and Economic Conservativism Scale (SECS).

Scoring.

Scoring of the SECS followed instructions provided by Everett (2013) in a SECS scoring sheet. Scoring instructions are reproduced below:

- Participants respond on a 0-100 scale, and scores can either be tied to intervals of 10 (0, 10, 20…100) or as a continuous measure.

- Economic and social conservatism items are indicated above in parentheses by an E or S respectively.
- Reverse code items 1 and 5 ("*Abortion*" and "*Welfare Benefits*"), and then create overall mean scores (or for the two subscales separately).
- Once mean scores are computed, mean values for participants will vary from 0 to 100, with higher scores indicating greater political conservatism.

The 12 items with E and S designations were:

1. Abortion (reverse scored). (S)
2. Limited government. (E)
3. Military and national security. (S)
4. Religion. (S)
5. Welfare benefits (reverse scored). (E)
6. Gun ownership. (E)
7. Traditional marriage. (S)
8. Traditional values. (S)
9. Fiscal responsibility. (E)
10. Business. (E)
11. The family unit. (S)
12. Patriotism. (S)

Data from the SECS scores were not analyzed statistically. However, the table below presents means for all subjects completing the SECS. Thus, subjects that withdrew from the study after behavioral training or had rejected EEG data during analysis are represented. Means and standard deviations are presented for overall scores as well as the

separated subscales. Observations and possible implications of these data are provided in the discussion section.

Table 5. SECS Means with Self-Reported Political Leaning and Age

Adolescent Group (18 – 19)					
Sub.	**Age**	**Leaning**	**μ-G**	**μ-E**	**μ-S**
1	18	Conservative	84.583	87	82.857
2	18	Conservative	66.25	61	70
3	18	Conservative	81.25	80	92.857
4	18	Liberal	54.16	56	52.857
5	21	Liberal	68.25	85	57.142
6	18	Conservative	73.3	81	67.8571
7	18	Conservative	67.25	72	63.8571
8	18	Liberal	32.5	30	34.29
9	18	Liberal	55.42	59	52.8571
10	18	Liberal	52.5	46	57.14
11	18	Conservative	72.91	75	71.428
12	18	Conservative	79	76	81.14
13	18	Conservative	71.6	68	74.28
14	19	Liberal	49.16	50	48.571
15	19	Conservative	62.5	66	60
16	18	Liberal	41.25	44	39.28
17	19	Conservative	80.83	78	82.8571
18	18	Conservative	78.75	62	90.71
19	19	Conservative	85.4	79	90
20	18	Liberal	62.5	50	71.42
21	19	Conservative	82.5	80	84.28
22	18	Conservative	65	61	67.8571
23	19	Conservative	81.25	60	96.42
Mean			67.3092609	65.4782609	69.128587
SD			14.441865	14.9084161	17.1310592
Adult Group (30 – 35)					
Sub.	**Age**	**Leaning**	**μ-G**	**μ-E**	**μ-S**
1	35	Liberal	17.5	20	15.7
2	35	Conservative	87	80	92.14
3	33	Liberal	42	49	37
4	30	Liberal	31.25	45	21.42
5	30	Liberal	59.58	65	55.71
Mean			47.466	51.8	44.394
SD			26.9280668	22.5543787	30.8769895

* Subject numbers do not correspond to subject IDs. Leaning reports how the subject self-categorized; μ-G represents the mean score for the entire SECS; μ-E and μ-S represent mean scores for the economic and social subscales respectively. The mean of means and standard deviations are listed below the scales.

Table 6. Conservative Subject SECS Means with Self-Reported Political Leaning and Age

Adolescent Group (18 – 19)					
Sub.	**Age**	**Leaning**	**μ-G**	**μ-E**	**μ-S**
1	18	Conservative	84.583	87	82.857
2	18	Conservative	66.25	61	70
3	18	Conservative	81.25	80	92.857
4 *(6)*	18	Conservative	73.3	81	67.8571
5 *(7)*	18	Conservative	67.25	72	63.8571
6 *(11)*	18	Conservative	72.91	75	71.428
7 *(12)*	18	Conservative	79	76	81.14
8 *(13)*	18	Conservative	71.6	68	74.28
9 *(15)*	19	Conservative	62.5	66	60
10 *(17)*	19	Conservative	80.83	78	82.8571
11 *(18)*	18	Conservative	78.75	62	90.71
12 *(19)*	19	Conservative	85.4	79	90
13 *(21)*	19	Conservative	82.5	80	84.28
14 *(22)*	18	Conservative	65	61	67.8571
15 *(23)*	19	Conservative	81.25	60	96.42
Mean			75.4915333	72.4	78.4266933
SD			7.58988666	8.78147401	11.3707892
Adult Group (30 – 35)					
Sub.	**Age**	**Leaning**	**μ-G**	**μ-E**	**μ-S**
1 *(2)*	35	Conservative	87	80	92.14

* Subject numbers do not correspond to subject IDs. Parenthetical numbering allows cross-reference to Table 5 Leaning reports how the subject self-categorized; μ-G represents the mean score for the entire SECS; μ-E and μ-S represent mean scores for the economic and social subscales respectively. The mean of means and standard deviations are listed below the scales.

Table 7. Liberal Subjects SECS Means with Self-Reported Political Leaning and Age

Adolescent Group (18 – 19)					
Sub.	**Age**	**Leaning**	**μ-G**	**μ-E**	**μ-S**
1 *(4)*	18	Liberal	54.16	56	52.857
2 *(5)*	21	Liberal	68.25	85	57.142
3 *(8)*	18	Liberal	32.5	30	34.29
4 *(9)*	18	Liberal	55.42	59	52.8571
5 (10)	18	Liberal	52.5	46	57.14
6 (14)	19	Liberal	49.16	50	48.571
7 (16)	18	Liberal	41.25	44	39.28
8 (20)	18	Liberal	62.5	50	71.42
Mean			51.9675	52.5	51.6946375
SD			11.3060929	15.7842598	11.451262
Adult Group (30 – 35)					
Sub.	**Age**	**Leaning**	**μ-G**	**μ-E**	**μ-S**
1	35	Liberal	17.5	20	15.7
3	33	Liberal	42	49	37
4	30	Liberal	31.25	45	21.42
5	30	Liberal	59.58	65	55.71
Mean			37.5825	44.75	32.4575
SD			17.7652439	18.6256991	17.9253384

* Subject numbers do not correspond to subject IDs. Parenthetical numbering allows cross-reference to Table 5 Leaning reports how the subject self-categorized; μ-G represents the mean score for the entire SECS; μ-E and μ-S represent mean scores for the economic and social subscales respectively. The mean of means and standard deviations are listed below the scales.

Table 8. Side-By-Side Comparison of Means of Means and Standard Deviations for Liberals and Conservatives

Adolescent Group (18 – 19)						
Values	**Lib SECS**	**Con SECS**	**Lib Econ**	**Con Econ**	**Lib Soc**	**Con Soc**
Mean	51.97	75.49	52.50	72.40	51.69	78.43
SD	11.31	7.59	15.78	8.78	11.45	11.37

* Lib = Liberal and refers to values for subjects self-identifying as liberal. Con = conservative. Because the adult group had only one conservative member a comparison table was not warranted. For comparison purposes the Adult group liberal secs mean was 37.58 (SD=17.77); the Adult, liberal economic subscale mean was 44.75 (SD=18.63); and the Adult, liberal social subscale mean was 32.46 (SD=17.93).

Experimental Testing

Electroencephalography and event related potential processing pipeline.

EEG preprocessing.

EEG/ERP preprocessing was conducted entirely within the EEGLAB (Delorme & Makeig, 2004) plugin ERPLab (Lopez-Calderon & Luck 2014). Preparing the raw EEG data for processing to enable downstream compatibility of the EPrime experimental output with EEGLAB required custom MATLAB code, which was provided by Dr. Taylor Bosch (Baugh Lab, University of South Dakota).

1) after setting channel locations, subjects' raw EEG data channels were filtered with an IIR Butterworth high-pass filter at 0.1 Hz (12dB/oct) with DC offset removed prior to filtering;
2) importing eventlist, assignment of bins, and bin-based epoching (-200 1200 ms) were then completed;
3) non-data channels were removed (EOG and Digital Input);
4) Data were re-filtered with an IIR Butterworth low-pass filter at 30 Hz (12dB/oct);
5) two forms of artifact detection were carried out in ERPLAB. First a moving window peak-to-peak threshold analysis was performed with a [-200.0 999.0]

test period, a 200 ms moving window and a 50 ms step on channels 1:9 for voltages exceeding 0.75μV. The second artifact detection algorithm run was ERPLAB Blink Detection on a [-200.0 799.0] test frame with normalized cross-covariance threshold set to 0.7 and blink width set to 200 ms on channels 1:9. Additionally, manual inspection was conducted on all trials for final inclusion decision. No rejections were performed, instead marked trials were excluded from ERP averaging via the ERP average GUI;

6) following artifact detection channels were clustered for additional analysis opportunities. Anterior (F3, Fz, F4), Central (C3, Cz, C4), Posterior (P3, Pz, P4), Left Hemisphere (F3, C3, P3), Midline (Fz, Cz, Pz), and Right Hemisphere (F4, C4, P4) clusters were computed in ERPLab's channel operation function with custom equations and added to preexisting electrodes;
7) channel locations were then reestablished;
8) data were z-transformed temporally; and
9) averaged ERPs were computed excluding marked artifact.

ERP processing.

Once averaged ERPs were computed for each subject, group-level ERP grand-averages were made. Grand averages included custom equations for further analysis (e.g., difference waves). Once grand averages were computed for both age groups—with 18–19-year-old subjects subdivided into above vs below chance—appended ERP datasets were created for ease of between-groups comparisons. In total three appended ERP grand-averaged datasets were created for initial inspection. Appending grand averages is a functionality available in ERPLAB that allows grand averages to remain separate but be

included in one ERP file. This process allows for side-by-side visual comparison of groups on main effects and interaction effects by allowing for the ERP traces for selected conditions to appear together. Appended ERP grand averaged datasets were created that (a) contained above- vs. below-average adolescents vs. adults, (b) all adolescents vs. adults, and (c) above-average adolescents vs. adults.

For the present study, averaged data from clustered electrode sites was not used. It was discovered that due to the low-density of the 9-channel EEG system used, clustered data sufficiently muted or obscured ERP components that individual midline electrode sites would be used instead. Furthermore, clustered midline electrodes resulted in a loss of the variance between Fz and Pz within the same latencies. This was problematic when results were found at Pz that did not match those at Fz or Cz, but that were arguably stimulus driven. Furthermore, whereas components of interest (P2 & N2) were *a priori* frontocentral based upon the task and the extant relevant literature, visual inspection of the ERP traces showed maximal responses during latencies of interest that appeared to differ as a function of age. Because P2 amplitudes over Pz rather than over frontocentral electrodes for adolescents appeared higher (this result was not present for the adults) the inclusion of Pz was warranted. Thus, data were collected from electrodes Fz, Cz, Pz on all subjects and for all conditions (see *Figure* 11).

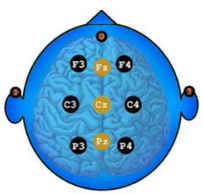


Figure 11. Midline electrode sites. International 10–20 montage.

ERP measurement.

A priori latency windows were selected for all ERPs of interest based upon a current understanding of the literature with consideration for stimulus modality and experimental task (Luck & Gaspelin, 2017). Manipulation checks were performed using ERPLAB "ERP-viewer" however no adjustments to ERP sampling window were made based upon visual inspection. The time windows for each ERP component of interest were (a) P2 [150.0 250.0]; (b) N2 [200.0 – 400.0] (Jodo & Kayama, 1992; Folstein & Van Petten 2008). All amplitudes were calculated as peak amplitude over 20 ms with qualitative positive vs. negative local peak defined for each measurement. Once measured in ERPLAB, all N2/P2 amplitude and latency data were imported to both excel and SPSS (v. 25.0) for further analysis. ERP traces for all conditions were created in ERPLAB.

Decision processes regarding chance performance on experimental task.

Subjects' task performance was evaluated using the button-press data recorded by EPrime during the experimental task. Custom Matlab code was then used to calculate the frequencies of hits (H), correct rejections (CR), false alarms (FA), misses (M), and no-response (NR). A hit (H) is any time a congruent stimulus is correctly identified as being congruent. This requires that the subject correctly identify the group to which the person pictured belongs and correctly identify the congruent statement. In the case of a hit the correct response on the button box is yes and the subject presses yes. A correct rejection (CR) is like a hit in that the subject has made a correct response, however, in this instance the subject has correctly identified that the image–statement pairing is incongruent. For a correct rejection (CR) the correct response on the button box is *no* and the subject selects

no. False alarms and misses both represent incorrect responses. A false alarm (FA) is when a subject believes that an image–statement pairing is congruent, but it is not. Thus, the correct response is *no* but the subject presses *yes* on the button box. A miss (M) occurs when an image–statement pairing is congruent, but the subject fails to detect the congruency. In the miss scenario the correct response is *yes*, but the subject selects *no* on the button box. No-response frequencies were not used for above- vs. below-chance performance calculations because it was not possible to tell if the NR was an NR of abstention or if the NR reflected a late response (e.g. slightly into fixation) that was not recorded by the SRBox (button box).

Once hits, misses, correct rejections, and false alarms were calculated for each subject, simple accuracy rates were created to determine chance performance using the following formula:

$$A = \frac{(H + CR)}{(H + M + FA + CR)}$$

Where A = accuracy; H=hit; CR=correct rejection; M=miss; and FA=false alarm. Above chance was defined as performance with an accuracy percentage at or above 64%. An accuracy level above 60% was selected to account for the possibility of performance that was randomly-better-than-chance. In other words, probabilistically some portion of below-chance performers would perform better than chance due to guessing. While it is possible to have perfect performance through probability alone, a higher threshold limits the number of individuals that will meet that criteria. See *Table* 9 for accuracies for present study along with the components used to calculate them.

Table 9. Subject Accuracies: Hits, Misses, False Alarms, Correct Rejections, and No Responses (by row)

	SUBJ	HIT	MISS	FALSE ALARM	CORRECT REJECTION	NO RESPONSE	ACCURACY
ADOLESCENT GROUP (18–19-years-of-age)	1	11	15	2	21	15	0.65
	2	21	5	3	21	14	0.84
	3	22	1	3	19	19	0.91
	4	17	9	12	14	12	0.60
	5	25	5	5	25	4	0.83
	6	17	10	17	12	8	0.52
	7	25	4	1	26	8	0.91
	8	18	12	16	12	6	0.52
	9	18	9	13	14	10	0.59
	10	11	18	5	19	11	0.57
	11	8	5	2	12	37	0.74
	12	22	7	12	16	7	0.66
	13	16	8	9	16	15	0.65
	14	11	11	12	16	14	0.54
	15	28	3	5	26	2	0.87
	16	16	15	18	13	2	0.47
	17	23	2	2	23	14	0.92
	18	28	4	8	21	3	0.80
	19	14	4	5	14	27	0.76
	20	16	13	12	13	10	0.54
	21	16	9	13	13	13	0.57
	SUBJ	HIT	MISS	FALSE ALARM	CORRECT REJECTION	NO RESPONSE	ACCURACY
ADULT GROUP (30 – 35-years-old)	1	22	3	3	27	9	0.89
	2	14	18	6	24	2	0.61
	3	27	4	3	26	4	0.88
	4	24	1	4	23	12	0.90
	5	27	3	6	25	3	0.85

Note. Each row is one subject's performance across measures. No response data may explain why ERP traces between above and below chance 18–19-year-old subject grand averages did not differ substantially. This observation (lack of difference in ERP response) led to the use of a combined adolescent group ERP grand average with 16 subjects. Threshold = .64 for above chance performance.

As with animal model research, human-subjects-based functional neuroimaging and electrophysiology studies investigating social cognition often require behaving subjects in the laboratory. Because task performance acts as a vehicle to the desired cognitive processes, it is reasonable to assume that individuals for whom performance is below chance also are not engaging in the cognitive processes of interest to the investigator. Based upon the chance-threshold of .64%, nine subjects were removed from the adolescent group (18–19-year-olds). Ultimately, no subjects were removed from the

adult group based upon performance. One subject's data from this group was eligible for removal based upon chance performance but had previously been removed from analysis due to excessive artifact stemming from an equipment malfunction (see Table 9).

However, due to the large number of ambiguous NR frequencies, coupled with a visual comparison of ERP traces on main effects and interaction effects of interest (group & congruency) between adolescent group members above vs. below the .64 threshold a decision was made to combine the above and below sub-groups. Thus, data presented as a part of this study reflect the combined data of 18–19-year-old subjects (n=16) regardless of accuracy. As previously mentioned, NR frequencies were ambiguous. Future iterations of the study would need ensure that button presses were logged regardless of time into fixation (while still flagging the late press). More continuous recording of button presses would, as is stated in the limitations section, isolate late presses from abstentions. Being able to discern later press from abstention would in turn provide the researcher an additional way to assess the design of the experimental task (e.g., timing of stimulus task) and would allow for NRs to be dealt with in a principled mathematical way.

Statistical analysis of ERP data.

MANOVA.

A multivariate analysis of variance (MANOVA) was conducted with electrode and condition as within-subjects factors and group (age) as the between subjects factor. Amplitude and latency were the dependent variables. Electrode had three levels corresponding to the three recording sites Fz, Cz, and Pz. Condition had four levels, congruent, incongruent, ingroup, outgroup. Group and had two levels, 18 (representing 18-19 yr. old group) and 30 (representing the 30-35 yr. old group).

The Ulrich-Miller Problem.

ANOVA results are presented for the P2 and N2 components to provide a sense for the data. However, there are limiting factors that preclude a face-value interpretation of the statistics. The limiting factors are specific to two problems inherent with this study's data. The first problem is that low recruitment numbers for both participant groups suggested the appropriateness of the jackknife method for grand-averaged data. A broad-sweep explanation of the approach is that in the creation of grand-average ERP datasets subsample scores are created for each subject (S_{i}, where i=1…n subjects). The result is a series of leave-one-out grand-averages where each grand-average is n-1 and is therefore very similar to the adjacent grand-averages with variance reflecting the contribution of the removed subject (Kiesel, Miller, Jolicæur, & Brisson, 2008). Jackknifed data ($S\_{1}…S\_{n}$) can then be used in much the same way that one would analyze single subject data (e.g., compute standard error, etc.). The approach has been shown to be extremely powerful, however, because there is no advantage to the approach over non-jackknifed grand-averages for analysis of amplitude, it is often only employed for latency analysis (where variance error is notorious) or in cases when the researcher/s need to recover representative sample sizes (to the group n's that made up each grand average).

It was with the latter goal in mind that the jackknife approach was applied to these data. Grand-averaged ERP data is often analyzed in a condition by electrode fashion that results in an artificial *n*. In other words, the electrode site is taken as the subject for analysis. However, in cases (such as this study) where a study has unequal group sizes (extremely so in our case) the use of electrode as subject is inappropriate. When subjects'

ERPs are averaged for a grand-average the researcher is left with one ERP dataset per group. Each group will have been subjected to the same conditions and will have had data recorded from the same number of electrode channels. Thus, the appearance of equal groups with equal observations is created. With a sufficiently large enough set of observations a study with unequal groups can easily report illusory ANOVA results. Of course, this is an academic problem more than one that is found in the published literature.

Returning to the Jackknife approach, in principle for unequal groups this approach works well. The restoration of inequality allows for the use of post-hoc analyses specific to cases of unequal group sizes (for example, Dunnett's T3 is appropriate for a study such as this with unequal but small samples). However, the combination of jackknifing the data and unequal groups creates a problem. When dealing with inflated *F*-ratios found as a result of the jackknifing process one is able to correct the value appropriately for the variance found in jackknifing (as opposed to that between subjects) by the following method: $F_c=F/(n\text{-}1)^2$ where n=the number of observations in each cell. Because no changes are made to degrees of freedom p_c of F_c can be derived from a standard F-table. However, the authors go on to state that unequal groups cause F_c to break down. According to Ulrich and Miller:

> They state that "the sum of squared errors must be adjusted for each cell separately before pooling these errors across all cells in the design. That is, the error term for each cell must be multiplied by the factor $1/(n_{cell} - 1)^2$, where n_{cell} is the number of subjects within the cell. After correction, these terms are pooled as usual across cells to compute the pooled within-cell variation. (2001, 822)

Based upon one interpretation of this correction, with *n*=19, sum of squared errors (*SSE*) should be multiplied by 324 (electrodes x conditions) before being pooled. Additionally, no clear guidance was found for pooling following the SSE correction. Therefore, with no clear description of the corrective operation, the results that follow do not reflect a corrected *SSE* or associated "pooled" results. Despite the failure to correct for unequal groups in the jackknifed data, the data presented provide evidence of a difference between adolescents and adults in social processing.

Chapter Six: Results

Experimental Testing

Box's M and Levine's Test were both significant at p<.0005, as was expected for subsamples of a grand average. Therefore, Pillai's Trace are reported for the following MANOVAs (see Table 10). Significant multivariate effects were found for all independent variables, however the variable *condition* contributed least to the model (Pillai's T =.292, F=23(6 ,816) p<.0005) when compared to ERP, Electrode, or Group (see Table 10).

Table 10. Significant Multivariate Effects (p<.05)

Variable(s)	Pillai's Trace	*F*	*df*	Error *df*	Sig.	ηp^2
ERP	**.976**	8270.7	2	407	.0005	.976
Electrode	**.655**	99.4	4	816	.0005	.328
Condition	.292	23.2	6	816	.0005	.146
Group	**.681**	433.9	2	407	.0005	.681
ERP*Electrode	**.780**	130.5	4	816	.0005	.390
ERP*Condition	.259	20.22	6	816	.0005	.129
ERP*Group	.507	209.57	2	407	.0005	.507
Electrode*Condition	.193	7.24	12	816	.0005	.096
Electrode*Group	.482	64.69	4	816	.0005	.241
Condition*Group	.307	24.7	6	816	.0005	.154
ERP*Electrode*Condition	.067	2.35	12	816	.0005	.033
ERP*Electrode*Group	.164	18.25	4	816	.0005	.082
ERP*Condition*Group	.088	6.24	6	816	.0005	.044
Electrode*Condition*Group	.235	9.03	12	816	.0005	.117
ERP*Electrode*Condition*Group	.089	3.182	12	816	.0005	.045

Table 11. Multiple Comparisons Across ERP, Electrode, Condition, and Group for P2 ERP Amplitude

Dependent Variable					Mean	Std. Error	95% Confidence Interval	
							Lower Bound	Upper Bound
Amplitude	P2	Fz	Congruent	Adolescent	0.010	0.013	-0.015	0.035
				Adult	0.413	0.030	0.355	0.472
			Incongruent	Adolescent	0.006	0.013	-0.020	0.031
				Adult	0.530	0.030	0.472	0.588
			Ingroup	Adolescent	0.041	0.013	0.015	0.066
				Adult	0.487	0.030	0.428	0.545
			Outgroup	Adolescent	-0.021	0.013	-0.046	0.004
				Adult	0.487	0.030	0.428	0.545
		Cz	Congruent	Adolescent	0.170	0.013	0.145	0.195
				Adult	0.393	0.030	0.335	0.452
			Incongruent	Adolescent	0.141	0.013	0.115	0.166
				Adult	0.577	0.030	0.518	0.635
			Ingroup	Adolescent	0.202	0.013	0.177	0.227
				Adult	0.497	0.030	0.438	0.555
			Outgroup	Adolescent	0.085	0.013	0.060	0.110
				Adult	0.490	0.030	0.432	0.548
		Pz	Congruent	Adolescent	0.183	0.013	0.158	0.208
				Adult	0.203	0.030	0.145	0.262
			Incongruent	Adolescent	0.179	0.013	0.154	0.204
				Adult	0.307	0.030	0.248	0.365
			Ingroup	Adolescent	0.184	0.013	0.159	0.209
				Adult	0.357	0.030	0.298	0.415
			Outgroup	Adolescent	0.165	0.013	0.140	0.190
				Adult	0.220	0.030	0.162	0.278

Table 12. Multiple Comparisons Across ERP, Electrode, Condition, and Group for N2 ERP Amplitude

Dependent Variable					Mean	Std. Error	95% Confidence Interval	
							Lower Bound	Upper Bound
Amplitude	N2	Fz	Congruent	Adolescent	-0.638	0.013	-0.663	-0.612
				Adult	-0.638	0.030	-0.742	-0.625
			Incongruent	Adolescent	-0.628	0.013	-0.653	-0.602
				Adult	-0.387	0.030	-0.445	-0.328
			Ingroup	Adolescent	-0.617	0.013	-0.642	-0.592
				Adult	-0.713	0.030	-0.772	-0.655
			Outgroup	Adolescent	-0.648	0.013	-0.673	-0.623
				Adult	-0.360	0.030	-0.418	-0.302
		Cz	Congruent	Adolescent	-0.486	0.013	-0.511	-0.461
				Adult	-0.553	0.030	-0.612	-0.495
			Incongruent	Adolescent	-0.509	0.013	-0.535	-0.484
				Adult	-0.127	0.030	-0.185	-0.068
			Ingroup	Adolescent	-0.491	0.013	-0.516	-0.466
				Adult	-0.453	0.030	-0.512	-0.395
			Outgroup	Adolescent	-0.488	0.013	-0.513	-0.463
				Adult	-0.240	0.030	-0.298	-0.182
		Pz	Congruent	Adolescent	-0.108	0.013	-0.133	-0.082
				Adult	-0.230	0.030	-0.288	-0.172
			Incongruent	Adolescent	-0.086	0.013	-0.111	-0.061
				Adult	-0.160	0.030	-0.218	-0.102
			Ingroup	Adolescent	-0.114	0.013	-0.139	-0.089
				Adult	-0.187	0.030	-0.245	-0.128
			Outgroup	Adolescent	-0.039	0.013	-0.064	-0.014
				Adult	-0.120	0.030	-0.178	-0.062

Table 13. Multiple Comparisons (Sidak) for Latency

						95% Confidence Interval	
Dependent Variable	(I) Condition	(J) Condition	Mean Diff (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Latency	Congruent	Incongruent	7.09*	1.465	.000	3.22	10.96
		Ingroup	4.46*	1.465	.015	0.58	8.33
		Outgroup	4.37*	1.465	.018	0.50	8.24
	Incongruent	Congruent	-7.09*	1.465	.000	-10.96	-3.22
		Ingroup	-2.63	1.465	.366	-6.50	1.24
		Outgroup	-2.72	1.465	.328	-6.59	1.15
	Ingroup	Congruent	-4.46*	1.465	.015	-8.33	-0.58
		Incongruent	2.63	1.465	.366	-1.24	6.50
		Outgroup	-0.09	1.465	1.00	-3.96	3.78
	Outgroup	Congruent	-4.37*	1.465	.018	-8.24	-0.50
		Incongruent	2.72	1.465	.328	-1.15	6.59
		Ingroup	0.09	1.465	1.00	-3.78	3.96

Based on the observed means. The error team is Mean Square (Error) = .003. *The mean difference is significant at the .05 level

Table 14. Multiple Comparisons (Sidak) for Amplitude

						95% Confidence Interval	
Dependent Variable	(I) Condition	(J) Condition	Mean Diff (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Amplitude	Congruent	Incongruent	-0.02728*	0.006798	.000	-0.04525	-0.00931
		Ingroup	-0.02184*	0.006798	.008	-0.03981	-0.00387
		Outgroup	-0.01360	0.006798	.247	-0.03157	0.00438
	Incongruent	Congruent	0.02728*	0.006798	.000	0.00931	0.04525
		Ingroup	0.00544	0.006798	.964	-0.01253	0.02341
		Outgroup	0.01368	0.006798	.240	-0.00429	0.03166
	Ingroup	Congruent	0.02184*	0.006798	.008	0.00387	0.03981
		Incongruent	-0.00544	0.006798	.964	-0.02341	0.01253
		Outgroup	0.00825	0.006798	.785	-0.00973	0.02622
	Outgroup	Congruent	0.01360	0.006798	.247	-0.00438	0.03157
		Incongruent	-0.01368	0.006798	.240	-0.03166	0.00429
		Ingroup	-0.00825	0.006798	.785	-0.02622	0.00973

Based on the observed means. The error team is Mean Square (Error) = .003. *The mean difference is significant at the .05 level

Hypothesis one.

Hypothesis one predicted that an age-mediated activation pattern would emerge as subjects processed the social stimuli. Maturational fMRI data have found that adolescents and adults engage different social cognitive and top-down control strategies when completing tasks related to socioemotional processing, including self-referencing, drawing inferences about others, and engaging control mechanisms for appropriate responses. As a reminder, past studies have found that adolescents engage a more isolated socioemotional network involving the dmPFC and the dorsal and ventral striatum, whereas adults show more distributed processing involving posterior portions of the temporal lobe, dlPFC, the ventral striatum, and regions of the parietal lobe such as the IPL. In short, adolescents have a more frontally centered, isolated, and inefficient circuit for tasks involving social cognition and affect, however, adults exhibit a more globally distributed, efficient modular network for the same tasks. Because the present study required subjects to self-reference, make inferences about outgroup members, and employ cognitive control this study is ideal for investigations of age-based differences in activation that occur within a short latency from stimulus onset. Based on the past fMRI observations hypothesis one predicted that adults would have more robust activation patterns over posterior electrode Pz and adolescents would have more maximal activation over frontocentral electrode Fz. Figures 12 and 13 show mean amplitudes for the P2 and N2 components for each midline electrode (Fz, Cz, Pz) when collapsed across conditions. Figure 12 reports mean amplitudes for the adult group (30–35) and figure 13 reports the same for the adolescent group.

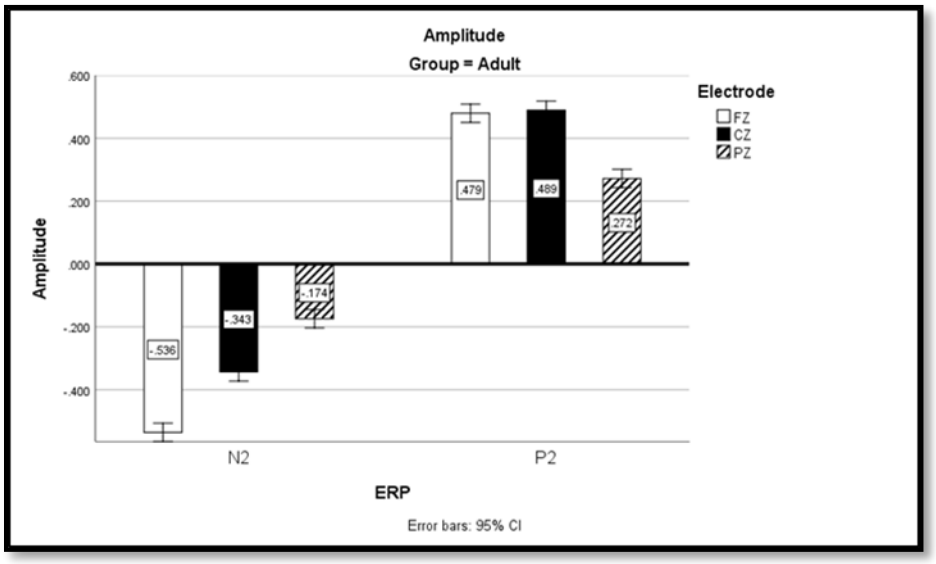


Figure 12. Adult group mean amplitudes (μV) across midline electrodes for the N2 (left) and P2 (right) ERP components. Note that these means collapse group and congruency conditions.

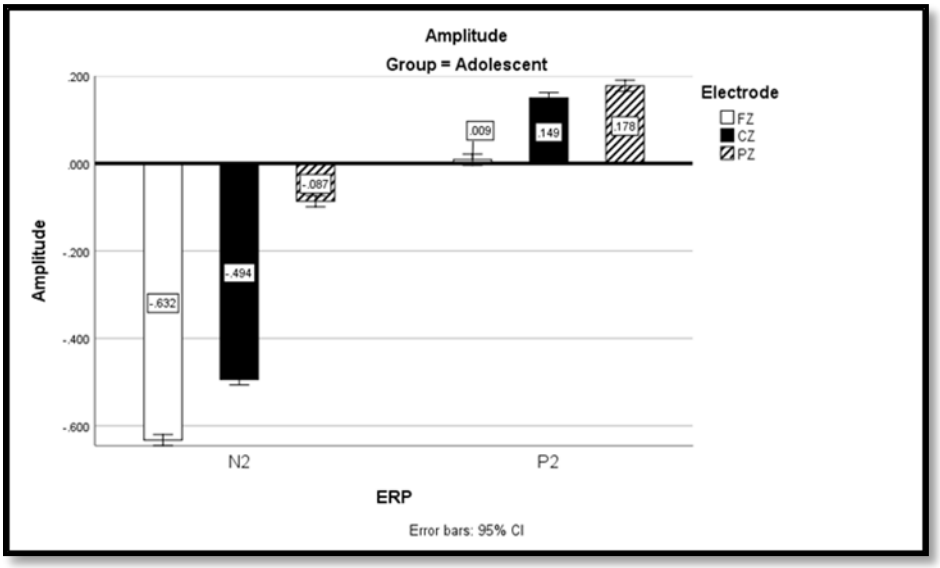


Figure 13. Adolescent group mean amplitudes (μV) across midline electrodes for the N2 (left) and P2 (right) ERP components. Note that these means collapse group and congruency conditions. Increased mean

Mean amplitudes for the adult vs. adolescent subjects are further displayed in Table 15 below. These data show that while the adults had overall larger activations over Pz, their most robust activations were over frontal and central midline electrodes. Furthermore, adolescent response over Pz for the P2 component (early vigilance) was reduced in comparison to the adult response over Pz, but across electrodes the P2 response was largest over Pz for adolescents. In other words, adolescents had more robust posterior activation over PZ than they did over Fz or Cz for the P2 component. Overall adults showed more activity over frontocentral midline electrodes for both P2 and N2 components and adolescents had more frontocentral activation for N2 but more posterior activation for P2.

Table 15. Between Groups Comparison of Mean Amplitudes by Electrode

		P2 ERP	N2 ERP
Adolescents	Fz	0.009	-0.632
	Cz	0.149	-0.494
	Pz	0.178	-0.087
Adults	Fz	0.479	-0.536
	Cz	0.489	-0.343
	Pz	0.272	-0.174

* Mean amplitudes are derived from leave-one-out jackknifed data. Amplitude is measured in microvolts (μV)

Hypothesis two.

Hypothesis two predicted that subjects from both age groups would have higher amplitude P2 ERP responses to outgroup members and higher amplitude N2 ERP components to ingroup members consistent with the findings of Ito and Urland (2003). However, based upon maturational data that indicates increased peer salience during adolescence it was predicted that adolescent N2 response to ingroup members would be more robust than adult N2 response to ingroup members across all midline electrodes (Fz, Cz, Pz). Figures 14 – 25 display data related to this hypothesis. Figures 14 and 15 are bar graphs showing between groups P2 and N2 (respectively) mean amplitudes for each condition's levels (ingroup, outgroup, congruent, incongruent).

Figure 14. Adult P2 data show more interest in congruency, in particular incongruent pairings, followed by ingroup and outgroup. Adult P2 responses were lowest for congruent conditions. Conversely, adolescents were more vigilant (P2) for ingroup members and congruent pairings (Figure 14). Adult N2 (cognitive control) responses are most robust for ingroup and congruent, which is consistent with the findings from the Ito studies. However, there was no difference between condition levels for adolescent N2 responses with each exhibiting a mean amplitude of ~ -.4 μV (Table 15).

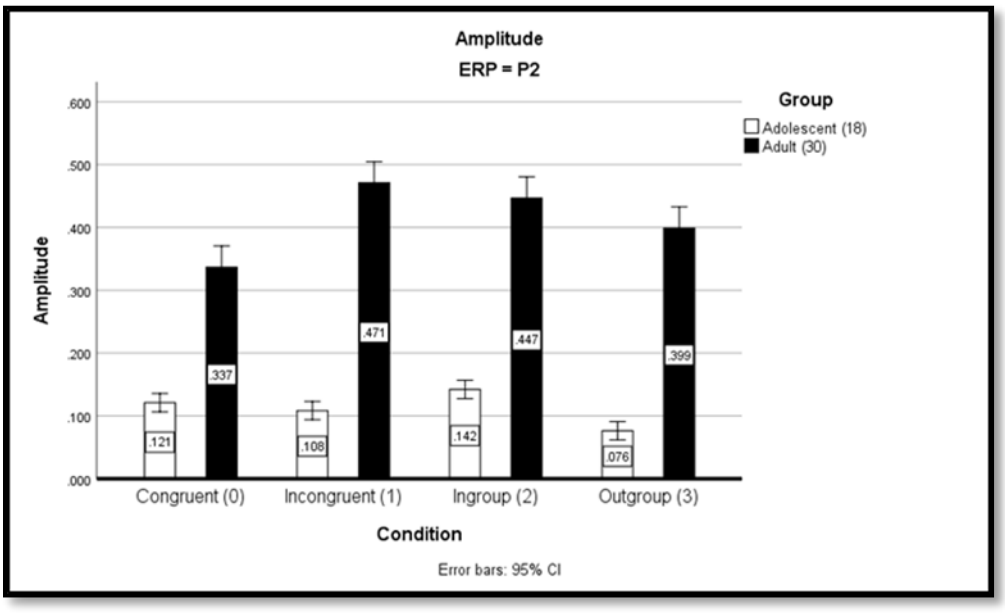


Figure 14. P2 mean amplitudes (μV) across midline electrodes for the group and congruency variables Note that these means collapse across electrodes.

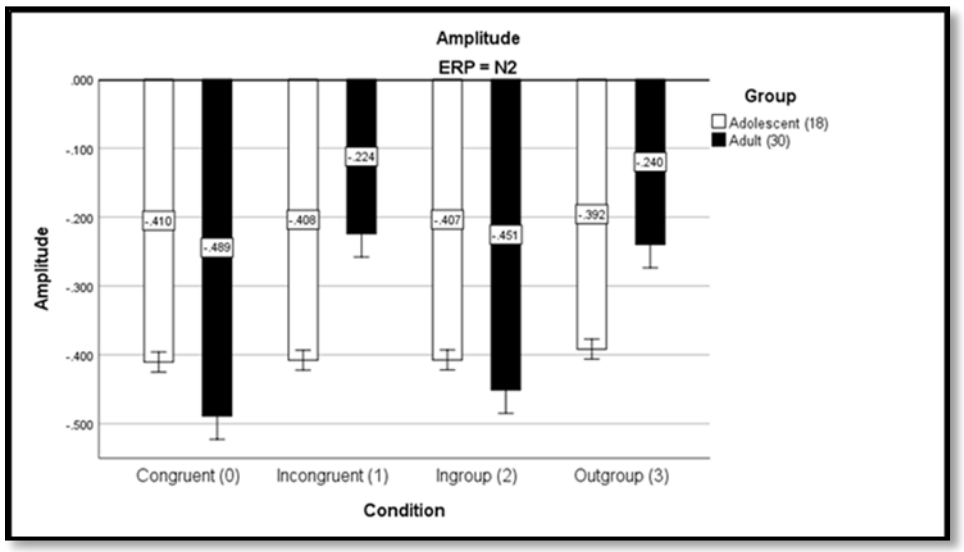


Figure 15. N2 mean amplitudes (μV) across midline electrodes for the group and congruency variables Note that these means collapse across electrodes.

Figures 16 - 18 display the ERP traces for the condition “congruency” and compare the main effects of the two levels of congruency: congruent vs incongruent on the dependent variable (ERP) levels P2 and N2. The P2 ERP traces for Fz (Figure 16), Cz (Figure 17), and Pz (Figure 18) show that adults and adolescents were vigilant for different aspects of congruency. Adults exhibited early vigilance for incongruent stimuli, whereas adolescents were more vigilant for congruent stimuli. N2 ERP traces show that adults had a more robust response to congruent stimuli, whereas adolescents had an equal cognitive control response to congruent and incongruent stimuli. Interestingly, the adult N2 response over Pz (Figure 18) did not match the response observed over Fz and Cz. Adult N2 response over Pz was stronger to incongruent stimuli as opposed to congruent stimuli as shown over Fz and Cz.

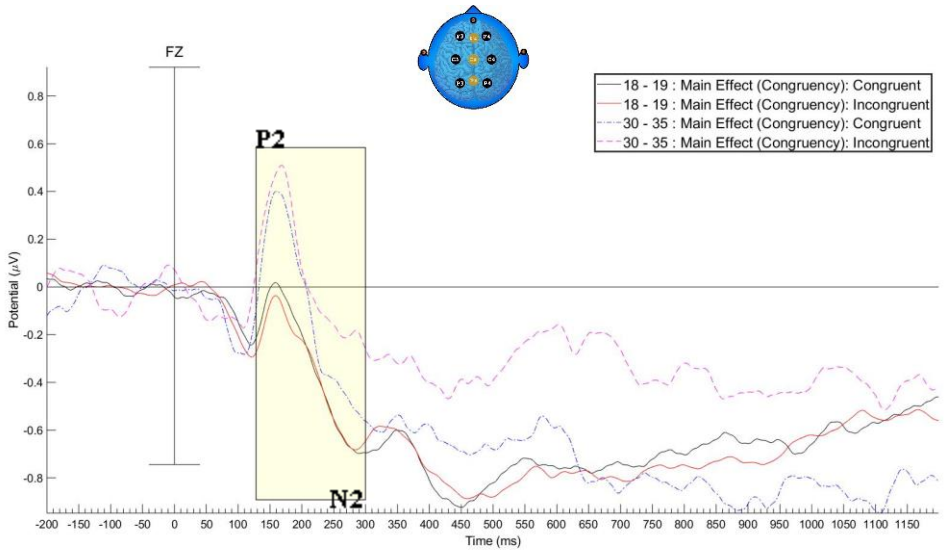


Figure 16. Main Effect = Congruency (Congruent vs. Incongruent).

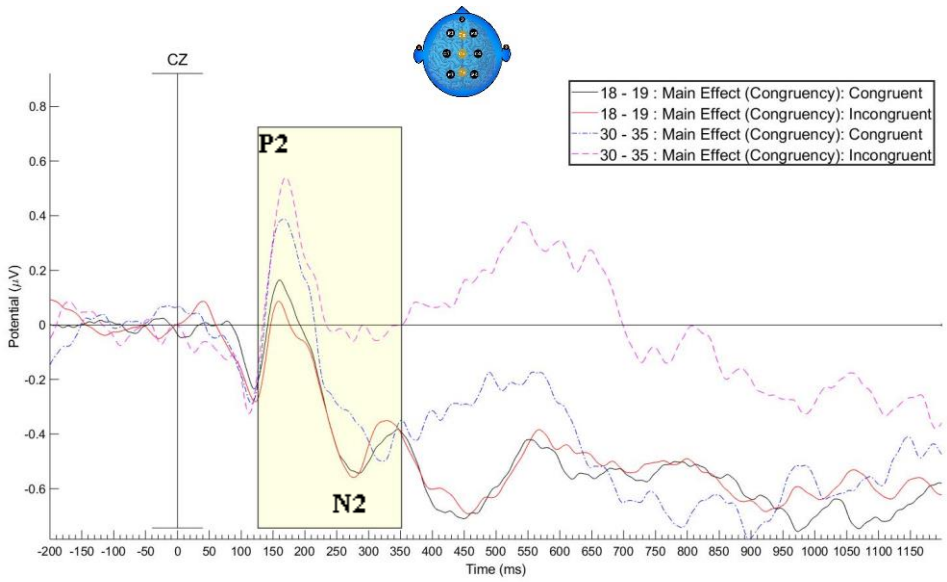


Figure 17. Main Effect = Congruency (Congruent vs. Incongruent).

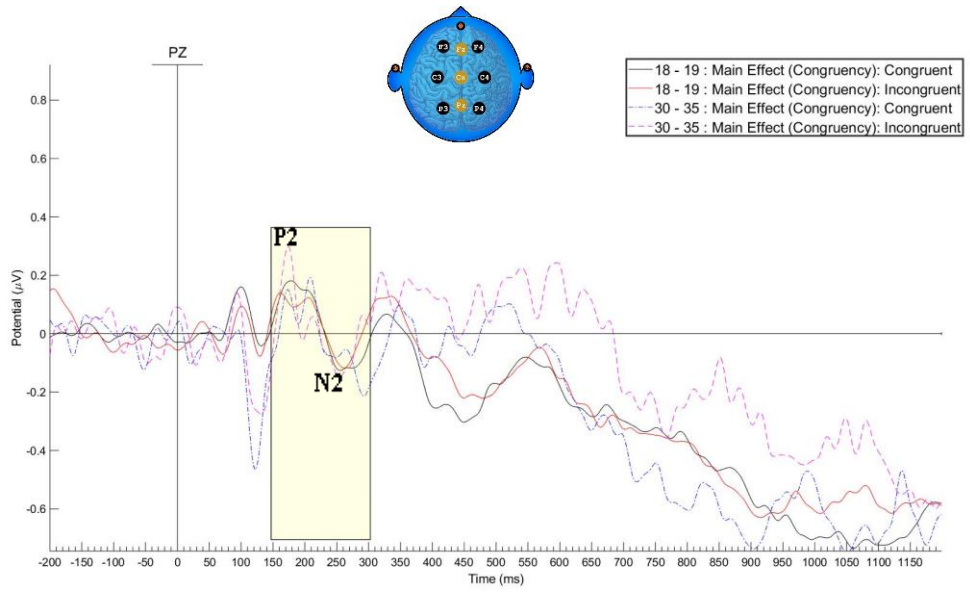


Figure 18. Main Effect = Congruency (Congruent vs. Incongruent).

Figures 19 – 21 display the ERP traces for the condition “group” and compares the main effects of the two levels of group: ingroup vs outgroup on the dependent variable (ERP) levels P2 and N2. As with the congruency traces, group figures are presented in an anterior to posterior orientation starting with Fz (Figure 19) then presenting the traces for Cz (Figure 20) and Pz (Figure 21). Adult P2 (early vigilance) response over Fz and Cz was the same for ingroup and outgroup stimuli, however N2 response showed an expected relationship with higher amplitude for ingroup than outgroup stimuli. Over Pz adults show a higher mean amplitude for ingroup rather than outgroup, and higher amplitude N2 to outgroup rather than ingroup. These results are contrary to those found by Ito and associates. Adolescents also show a trend opposite to that found in the Ito studies. However, the contrary results for adolescents occur over Fz and Cz, followed by a switch to an expected P2-N2 effect over Pz. Over Fz (Figure 19) and Cz (Figure 20) adolescents show larger P2 for ingroup and larger N2 for outgroup, but over Pz (Figure 21) adolescents have a larger P2 for outgroup and larger N2 for ingroup members.

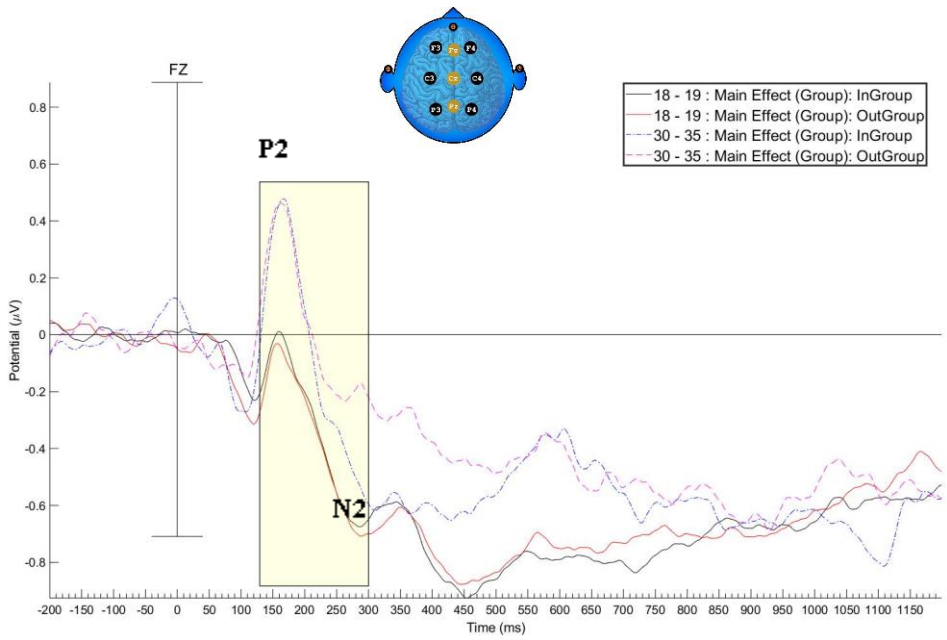


Figure 19. Main Effect = Group (Ingroup vs. Outgroup).

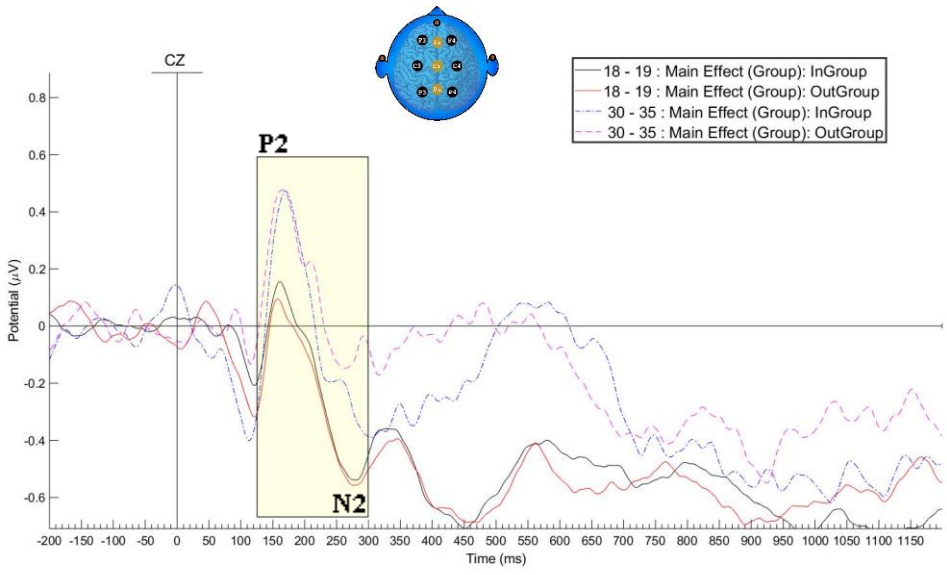


Figure 20. Main Effect = Group (Ingroup vs. Outgroup).

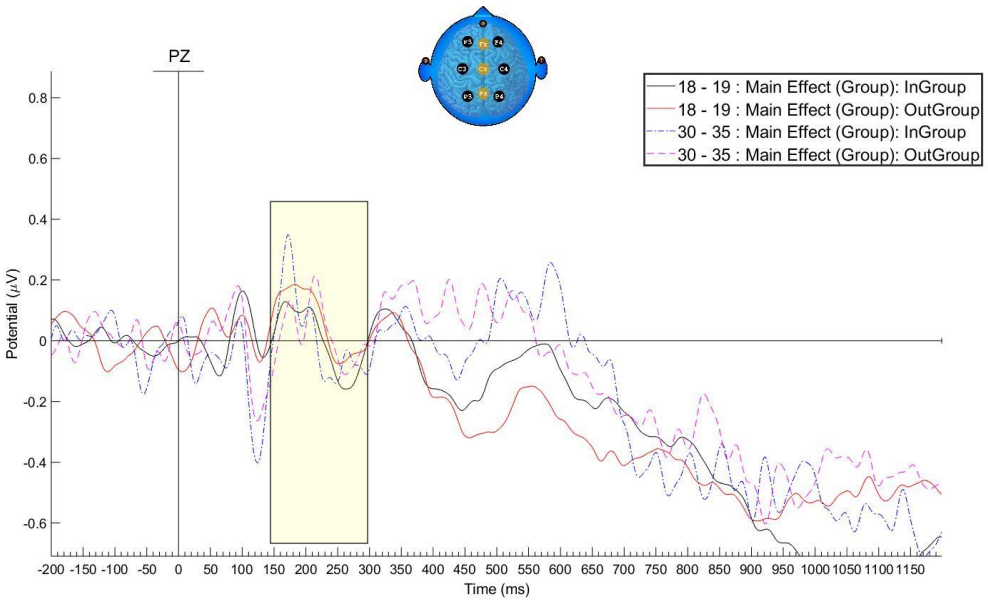


Figure 21. Main Effect = Group (Ingroup vs. Outgroup).

Figures 22 – 25 show ERP traces for two-way interactions. Each interaction holds one level of one condition constant and compares the interaction effects of the two levels of the other condition. For example, Figure 22 holds the group level ingroup constant while comparing the effects of congruency (congruent vs. incongruent). Each two-way interaction ERP trace is over electrode Cz.

Figure 22 shows that adults' P2 and N2 ERPs were stronger for congruent–ingroup stimuli. Whereas, adolescents had a slightly higher P2 amplitude for congruent–ingroup stimuli and a higher N2 ERP for incongruent–ingroup stimuli. Figure 23 holds outgroup constant and varies congruency. Adult P2 ERP response was robust to incongruent–outgroup stimuli, and their N2 response favored incongruent–outgroup stimuli as well. Adolescents had higher P2 and N2 responses to congruent–outgroup stimuli.

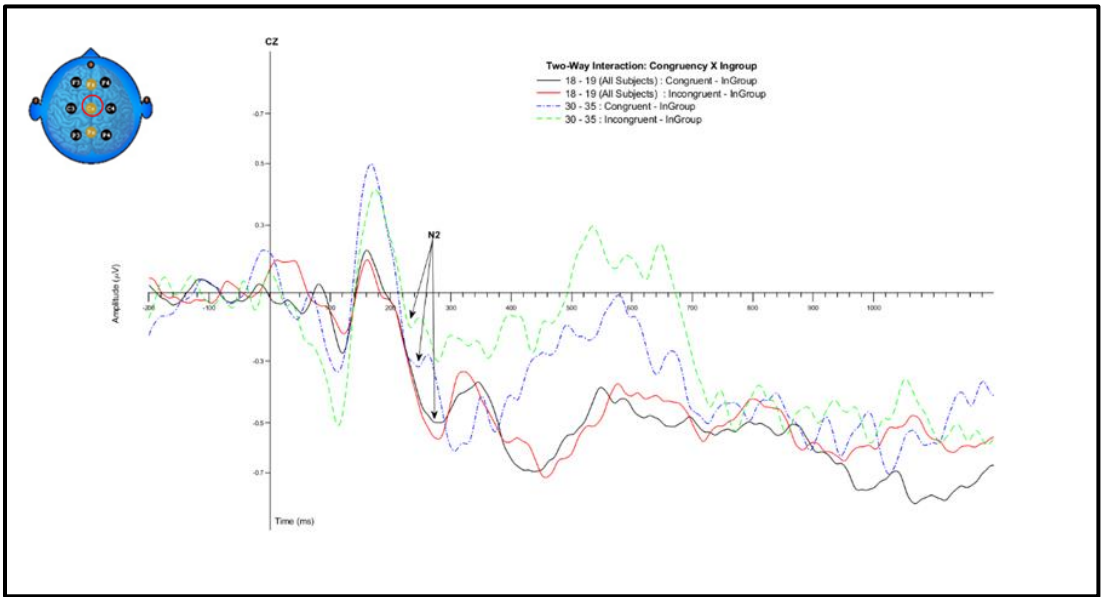


Figure 22. Two-way interaction: Congruency X Ingroup (Cz)

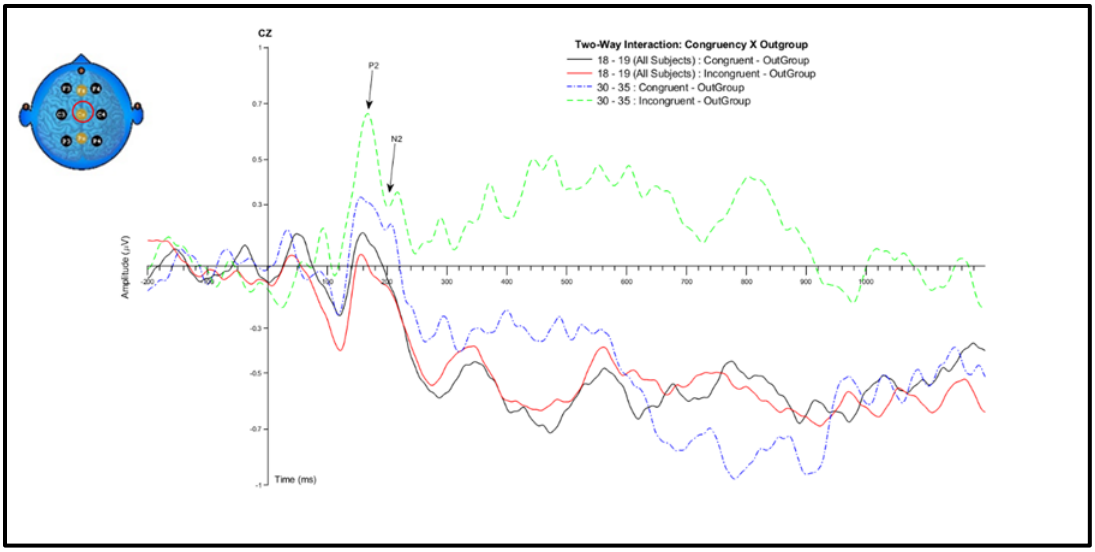


Figure 23. Two-way interaction: Congruency X Outgroup (Cz)

Figures 24 and 25 hold congruency constant while varying group levels. Figure 24 holds “congruent” constant and varies group. The Figure 24 ERP trace shows a higher mean P2 amplitude for the congruent–ingroup condition for adults and no P2 effect for ingroup or outgroup for adolescents (amplitudes were not different). Adult N2 ERP is higher for congruent–outgroup and has a later onset latency when compared to congruent–ingroup. Similarly, adolescents had higher N2 amplitudes for congruent–outgroup stimuli. Figure 25 holds “incongruent’ constant and varies group levels. On incongruent pairings, adult P2 response was larger for outgroup and N2 was larger for ingroup. In contrast, adolescents had larger P2 and N2 ERPs for ingroup–incongruent pairings.

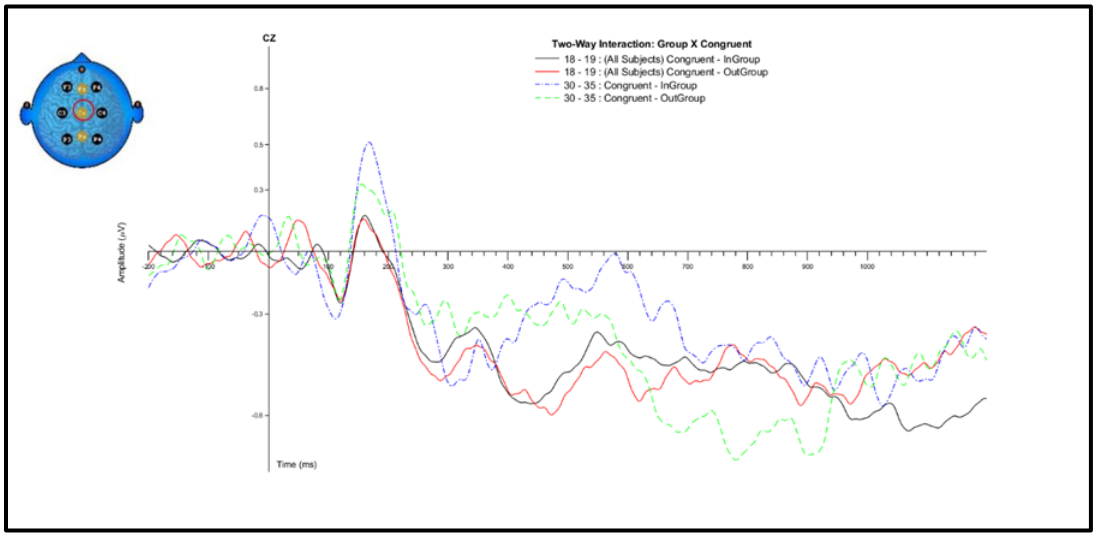


Figure 24. Two-way interaction: Congruent X Group (Cz)

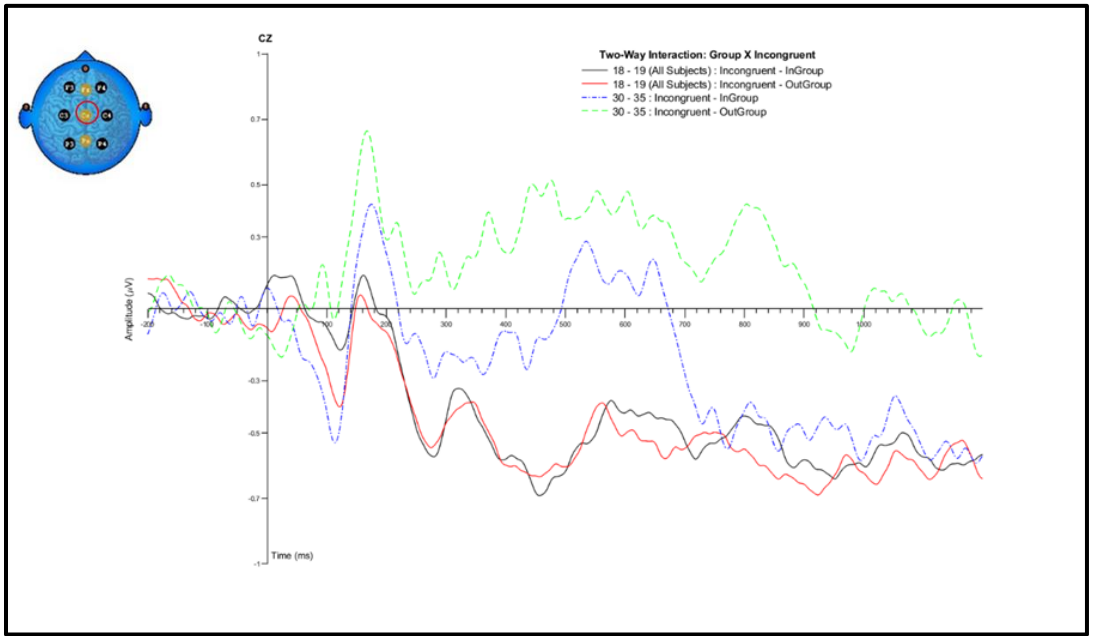


Figure 25. Change over Cz. Two-way interaction between group and congruency holding the incongruent condition steady and varying group membership (ingroup vs. outgroup). Note that the adolescent group maintained a higher P2 amplitude for ingroup despite the incongruent condition (cf. *Figure* 24).

Chapter Seven: Discussion

The preponderance of neuromaturational data indicates that reorganization of the brain across the second and first half of the third decade of life can account for differences in social cognitive processes observed between those that fall within this age-span and those 30-years-old and older. Additionally, sexual dimorphism in the human brain and dimorphic variance in the onset of sexual maturational processes may explain the differences in timing and amount of ultra-tribalistic coalitional violence engaged in across the lifespan. Traditional methods, such as self-report data, are not able to access group-level differences in human cognition free of post hoc rationalizations that have been generally found to be flawed. Additionally, these methods are unable to access the "black box" of early intergroup processing that occurs within the first 300 ms after encountering a stimulus. Functional magnetic resonance imaging has provided a great deal of insight into neuromaturational trajectories and functional circuitry within the human brain; however, fMRI is also limited by poor temporal resolution.

This study addresses the need for basic social neuroscience research with high temporal resolution capabilities within sociological social psychology by examining differences in intergroup processing in two neuromaturationally distinct groups. The P2 and N2 ERP components were selected because of their consistent relationship in the presences of ingroup and outgroup images. While humans are preferentially sensitive to visual cues, the present study challenges the notion that American racial categories are meaningful at a neurological level. Instead the broader, ingroup and outgroup, however that is defined individually and locally, makes more sense from an evolutionary perspective.

This study tested two hypotheses related to developmental mismatch . The first (H1) tests peer salience and investigates differences in N2 amplitude between adults and adolescents. Because peer salience is heightened during adolescence it was predicted that adolescents would spend more time processing ingroup images and would therefore apply more ACC-generated cognitive control as indexed by N2 amplitude. Then the study investigated network distribution. It is widely accepted that electrophysiology has poor spatial resolution and is inappropriate for localization. However, because this study used a low-density array with widely spaced electrode sites it was believed that a shift in social processing and self-referencing to posterior brain regions would result in higher amplitude activations over posterior electrodes. Moreover, the components of interest have been observed across midline electrodes in response to both ingroup and outgroup stimuli. Continuity, it was believed, across midline electrode sites would offer an opportunity to observe age-related amplitude shifts in the group-level data. Currently the time-course for specific network node activations is unknown, and this study was interested in whether the distributive shift could be observed in the 30–35-year-olds' early ERP components.

Major Findings

Hypothesis one.

Hypothesis one predicted that there would be a clear age-based activation pattern with adolescents exhibiting more robust frontocentral activation and adults more posterior activation. These results were not found. Based upon mean amplitudes at each electrode site, collapsed across conditions, for the two dependent variable levels: P2 and N2 ERP components (Figures 13 and 14; Table 15). Therefore, the null hypothesis is not

rejected. Put plainly, no age–mediated posterior pattern was discernable for the adult group vs. the adolescent group in the ERP data.

Despite failing to reject the null hypothesis, some interesting results emerged. As noted in the initial description of the data for Figures 13 and 14 and Table 15, adults showed robust frontocentral activation for vigilance and control. While there was not a posterior-weighted distribution for adults, responses over Pz for both ERP components were more robust than they were for adolescents. Adult N2 data show an anterior to posterior directionality with highest amplitudes over Fz, and amplitude reduction stair-stepped down through Cz and Pz. However adult N2 amplitudes showed an even step of -0.2 μV between each electrode, which may provide evidence of global social-brain network distribution in early component activation. Adult P2 data over frontocentral electrodes were not different, but between frontocentral electrodes and posterior Pz electrode the [.2] μV difference reemerges. It is possible that this finding reflects fMRI data showing that adults engage memory more when assessing self–other stimuli due to the distribution (Somerville et al., 2011). Adolescents on the other hand showed higher amplitude P2 ERPs over Pz and Cz, with the highest amplitude over Pz and minimal (.009 μV) mean amplitude over Fz. The posterior to central orientation unique to the adolescents may reflect fMRI data that suggests that adolescents make self-reference and other-comparisons in a more “on-line” manner (i.e., in the moment appraisals) by suggesting a greater reliance on primary, secondary, and tertiary visual cortices (Somerville et al., 2011). This assessment is also supported by the adolescent N2 data which is robust over frontocentral electrodes and may suggest the adolescent PFC – striatum circuit described by Somerville and associates (2011).

Failure to reject the null is most likely due to the temporal sensitivity of EEG vs fMRI. That is, activation differences reported from fMRI data are unable to describe the temporal resolution of the distributed activation patterns. The present study was interested in this question because of the speed of processing associated with social categorization and the possibility of discerning a clear difference in these distinct groups. In addition to the poor spatial resolution of EEG, making the task more difficult was use of a low-density EEG array (9 channels). Therefore, it is more plausible that failure to properly assess hypothesis one is due to design flaws and equipment limitations and not the absence of fast-activating circuits distributed as predicted.

Hypothesis two.

Hypothesis two was not assessed due to several factors. First the extremely small adult group leave the results intriguing but inappropriate for hypothesis testing. Additionally, at the group level, it is difficult to know if the data reflects a true average or if one subject (in the adult group) is driving the results. A second reason for failing to assess the hypothesis is that the hypothesis states that the study's findings will mimic those of the Ito and Urland (2003) with respect to ingroup vs. outgroup processing but will differ only in a measure of peer salience. The present study's data did not mimic Ito's data at all surprisingly. In fact, where Ito has regularly found stereotyped results across central electrode sites, these data had reversals at Fz and Cz with only Pz exhibiting a similar P2-N2 relationship to that of Ito's findings. The complexity of the task and some emerging trends from the data are discussed below.

Hypothesis two predicted that subjects from both age groups would have higher amplitude P2 ERP responses to outgroup members and higher amplitude N2 ERP

components to ingroup members consistent with the findings of Ito and colleagues. However, based upon maturational data that indicates increased peer salience during adolescence, it was predicted that adolescent N2 response to ingroup members would be more robust than adult N2 response to ingroup members across all midline electrodes (Fz, Cz, Pz). Figures 14 – 25 display data related to this hypothesis. Figures 14 and 15 are bar graphs showing between groups P2 and N2 (respectively) mean amplitudes for each condition's levels (ingroup, outgroup, congruent, incongruent) and Figures 16 – 25 show ERP traces for main effects and two-way comparisons. Only Figures 14 and 15 are discussed here because they summarize the trace data, but the reader is referred to the ERP traces and their descriptions for more individualized assessments of the main effects and two-way interactions.

While the hypothesis was not supported, an interesting result emerged that warrants further investigation. Adolescent and adult subjects appeared to be motivated differently. In other words, the conditions and condition pairings that were salient to adults were not the same as those salient to adolescents. Figure 14 illustrates this difference showing that for ERPs indexing early vigilance (P2) the adults were more vigilant for incongruent situations followed by ingroup then outgroup. In other words, the adults were sensitive to incorrect stereotypes of their own group followed by incorrect stereotypes of an outgroup and were less interested when the stereotypes for either group matched representations that they were comfortable with. Adolescents on the other hand were vigilant first for ingroup members and second to congruent conditions. Cognitive control indexed by N2 is believed to represent control applied to familiar people or things so that more consideration can be given (Ito and Urland, 2003). It is well known that

individuals find more nuance in their own group than they do in an outgroup, which often gets the broad strokes approach. Because of this well-known finding, it was interesting that adolescents showed no difference in mean levels of cognitive control across conditions. This result may also be supported by the Somerville et al. (2011) finding that adolescents activated inferior frontal gyrus more often and more robustly to control unwanted actions. Adult N2 responses were consistent with those found by Ito with higher amplitude for ingroup members.

An alternative explanation for the motivational differences found between adolescents and adults is provided by the ingroup projection model and superordinate identities (Wenzel, Mummendey, & Waldzus, 2007). According to Wenzel et al. the basis of the ingroup projection model is that ingroup and outgroup qualities are determined by referencing some shared superordinate identity (2007). Positive feelings about the ingroup—within which members are interchangeable—derive from a feeling that the group represents the exemplar of the superordinate category. Negative evaluations of the outgroup do not simply occur because outgroups exist in a shared space, but instead arise when an outgroup differs in some way to the ingroup and believes that they represent the superordinate category (Wenzel et al., 2007). Using the present study as an example, the superordinate category could be "American," whereas the ingroup and outgroup would be the two political orientations. If members of each group see membership in the group as granting status as an exemplar American conflict must occur to resolve the issue of prototypicality. However, if only one group finds the superordinate category "American" salient based upon group membership no conflict should arise.

According to Wenzel et al.:

> Through ingroup projection, members regard attributes that are, in a given context, stereotypical and distinctive of their ingroup as prototypical and, thus, normative and positive. …the outgroup's difference becomes deviance…and…may be considered a violation of the norms implied in the superordinate category. From the perspective of the ingroup projection model, the evaluation of intergroup differences depends, first, on whether the ingroup and outgroup are perceived to be included in a shared superordinate category. If not, there is no expectation that the outgroup comply with the same norms or values as the ingroup. The outgroup's difference is not identity threatening and can be observed in a neutral or even interested way, as something irrelevant or perhaps exotic. (2007, pp. 338 + 340)

Wenzel and colleagues (2007) provide compelling data from multiple research domains that support their model.

Turning back to the present study's data, using an ingroup projection framework/lens, it is possible that for the adolescent participants differences between the subgroup categories were not significant enough to engender a conflict over superordinate identity. As shown in Tables five through eight, SECS scores for those identifying as liberal were around the 50% mark on both social and economic subscales, and not identifiably "liberal" when compared to the adult scores. Considering the conservative nature of South Dakota, it is possible that these subjects were "liberal" when compared to those around them. However, the middle-of-the-road scores may have made evaluating stimulus-statement pairings difficult, in that those items stereotypically

opposite to their stated orientation may have been salient and viewed positively. This situation would have created two problems. The first would have been an increased chance for incorrect responding on the task. The second, related to ingroup projection, would have been an inability on the part of the researcher to contrive competition over a superordinate identity. In other words, many of the congruent-outgroup stimuli may have reflected ingroup members outside the laboratory. Without internal gauges of prototypicality, the adolescents would apply equal amounts of cognitive load to all conditions and would not show an appreciable preference for ingroup over outgroup. That is exactly what the data showed. Adolescents were preferentially interested in group but not specifically interested in one level over the other, and N2 (control) responses were equal across conditions indicating that the adolescents were taking the same, longer, amount of time to process stimuli typically reserved for ingroups only.

Limitations of the Present Study

Design.

The study's design had several limiting factors including inadequate trial numbers, difficulty separating congruency from group, no recorded data for nonresponses. Each limitation will be discussed below.

Initially, 64 trials were believed to be adequate for the experimental goals. Under this model subjects viewed each condition 16 times. However, it was discovered during EEG preprocessing and ERP processing that trial removal due to artifact resulted in a significant reduction in available trials per condition per subject (bins were weighted). Image counts for the ingroup needed to be manageable for the subjects when considering the available laboratory time for memorization. Therefore, introducing a short in-place

break (without removing equipment) and then initiating a second run of the experiment would have provided enough trial for each subject/condition to overcome periods of movement artifact or periodic equipment artifact (e.g., electrode pop). Additionally, a second run of the experiment would have increased the likelihood of obtaining data for every image-statement pairing. Subjects that "timed-out" on an image would have a second opportunity. By including a short break, the response data could also be initially looked at separately to test for practice effects.

In addition to a second run of the experiment, control conditions that only represent congruency or group need to be added. The design allows for comparison of main effects as well as two- and three-way interactions along multiple dimensions (group and congruency are the only ones reported here), however, interpretation of the results is difficult when examining main effects because the separation of group and congruency is artificial. While the averaging of all ingroup, outgroup, congruent, or incongruent data for an age group may yield a representative main effect, the inclusion of a control condition would reduce the ambiguity in the current interpretation.

Not allowing for responses made after the onset of fixation to be recorded was a mistake. Due to the extremely complex nature of the task and short time frame to complete it in it is believed (and was observed) that some portion of non-responses on trials was due to the response occurring at the switch to fixation or immediately after. The loss of these data made performance assessment difficult as discussed in the method section. To correct this, the EPrime experiment would be modified to record button presses occurring within the first 200 ms of fixation.

Sample.

Sample sizes were extremely small, which made interpretation of results difficult. Some of the difficulty in recruitment was due to low compensation relative to comparable studies. Financial resources were not available for two primary reasons. First the student P.I. is an unfunded student, and as a result, the entirety of the study's costs was an out-of-pocket expense. Second, grant applications were encouraged to include pilot data for successful submission. However, pilot data were not available, and the cost associated with the initiation of a pilot study would have made the dissertation research cost financially prohibitive.

Additionally, recruitment was hampered because the same equipment was used at both research sites. Thus, scheduling participants at the Sioux Falls research site required testing to be suspended at the Vermillion location. Testing in Sioux Falls was completed in seven-day blocks to account for behavioral and experimental testing. In hindsight, recruitment and testing in Sioux Falls should have preceded the same in Vermillion to capitalize on the greater 30–35-year-old population in Sioux Falls and to account for the easier recruitment within the adolescent group.

Future Directions for the Present Research

For the present study, multiple dimensions of the study were not reported but are available for further analysis. The first is ERP comparisons based upon gender, race, and age. In particular, the analysis of age will be an important next step. Hypothesis two predicted a difference in peer salience between adolescents and adults. Reanalyzing the data looking at same-age versus different age effects may yield interesting results. It is possible that adolescent peer salience is bounded by members of their generational age

group. In other words, an adolescent may belong to a group with mixed ages, but only experience increased peer-salience for that subset of individuals that the adolescent perceives as similar in age.

The current study's use of notional groups offered an innovative way to deal with barriers the researcher faced when designing the protocol. However, using the present study as pilot data, there is the possibility of using "live" groups (where research confederates are group members). Interactions with actual group members may reduce memorization demands, make the study more interesting for participants, and provide a better approximation to group dynamics outside of the laboratory. Finally, future expansions on the present protocol should include more engaging tasks to facilitate prolonged experimental time. For example, use of games like prisoner's dilemma and preemptive strike in addition to a modified version of the stimuli presented in the present study may better address questions about differences in intergroup bias between age groups. Additionally, eye tracking data were collected for pupillometry that may yield additional insight into age-related intergroup assessments. Eye-tracking data may also provide insight into the complexity of the task by assessing participant action-selection sequences. Finally, recruiting right-handed females for the study will allow for comparison of sex-matched groups.

Future Directions Concerning the Intersection of Sociology and Evolution, Biology, and Neuroscience

In the earliest days of American Sociology, students of society appear to have been well-read in philosophy, biology, chemistry, evolutionary theory, and much more. Not only does it appear that sociologists were aware of work in other disciplines—they

seem to have considered it all to be valuable for understanding human social organization from the dyad to the nation-state. For example, the 1896 *Index to Sociological Literature in the Periodicals* includes topics as diverse as law and economics; labor; social forces; mental health; microbiology; genetics; geology; and education (AJS, 1896). While, the science of that era leaves a lot to be desired, disciplines that did not abandon the slow march of progress or interdisciplinary explanations are now reaping their rewards as sociology is slowly being disinvited from the table and conversation.

In 2019, it is increasingly difficult for sociological social psychologists to reasonably argue against the incorporation of evolutionary theory (Lopreato, 1990; Massey, 2002; Figueredo et al., 2006; Ellis et al., 2012) and neuroscience (see Cacioppo et al. 2002). Old tropes about eugenics, phrenology, social Darwinism, etc. are outmoded and do not reflect the current state of biology, chemistry, genetics, evolutionary theory, or neuroscience (Dietz, Burns, & Buttel, 1990; Lopreato, 1990; Pierce & White, 1999; Booth, Carver, & Granger, 2000; Massey, 2001; Machalek & Martin, 2004; Thagard & Findlay, 2010). However, according to Sloss (2002), sociological students will have to overcome the same barriers faced by students in a religious fundamentalist community if they want formal and honest education in social theories that address evolutionary theory and human biology. Sloss recounts an unsuccessful attempt to find just one sociological textbook that had up-to-date bio-psycho-social theory, mentioned or explained natural selection, or understood that nature vs. nurture is no longer “a thing”—the debate having been settled long ago (2002).

Overcoming knowledge gaps is no small task, but certainly manageable. Furthermore, normalization of integrated evidence will most likely come once sociologists (and social psychologists in particular) begin conducting the basic and translational social neuroscience research themselves, as opposed to quote mining pop-science books that do not convey the depth of the neuroscience, or cherry picking inappropriate biological or evolutionary theory data that becomes a shibboleth for those of us with formal education in the natural sciences. Doing the work will necessarily lead to greater understanding of the underlying mechanisms of action.

There are circles that claim that taking this route is not "sociological." However, they are simply misinformed about the history of sociological practice—which included experimental methods and a great deal of interdisciplinary theory- and method-mixing. Moreover, the claims today of "what sociology is and isn't" simply are not supported by a cursory glance at the major introductory sociology textbooks in use between 1890 and the present in the United States. Inability to "pin down" sociology is not a new problem. In 1906, George Vincent wrote an article on the topic "what is sociology" for the University of Chicago Sociology Club. Vincent laments that for 14 years the university has had a sociology department and for 10 of those years they have produced *The American Journal of Sociology*, and yet this question still plagues sociologists, and causes debate among sociology students (1906). The problem of having to explain what one does exactly was not, according to Vincent (1906), a problem shared by physics or chemistry or psychology—it was sociology's burden alone.

In reply to the sociology club's request Vincent concluded that the reason the question was difficult, or that there was such great disagreement about method and theory was that there simply wasn't one sociology.

> The answer is obvious. Sociology is not one; it is many. There are varieties of sociology. If these have a specific unity, this is largely obscured by the patent diversities. The term "sociology" means several different things, brings up a variety of images in the minds of men and women today. Hence the impossibility of saying definitely and definitively what sociology is. Most of the articles which bear the familiar heading might better be entitled "What Sociology Ought to Be." Still, in spite of all, "sociology" continues to be a noun of multitude…
>
> "Sociology" is the name for the large cabinet within which are to be found the pigeon- holes of the various social sciences. Thus, in Dewey's library system "sociology" is the main heading, under which "political economy," "political science," "anthropology," "ethnology," "penology," etc., form subgroups. This use of the term is convenient and has the sanction of good usage. In the annual French publication, *L'Annee sociologique*," one finds subdivisions into "general sociology," "religious sociology," "moral and juridical sociology," "economic sociology," etc. In the first publication of the London Sociological Society there are papers on "Eugenics," "Civics," "The Position of Woman in Early Civilizations," and "Life in an Agricultural Village in England." Whether sociology ought to be used in this comprehensive fashion to include all aspects of social phenomena is, perhaps, fit subject for academic discussion, but such

> discussion would have little influence upon the facts. The word is used, and by intelligent people, as a label for all things social. (1906, pp. 2–4)

Sociologist H.W. Odum recognized the need for a broad view investigative possibility when he quoted Karl Pearson's *Grammar of Science* (1911 [1892; 1900]) as:

> Now this is the peculiarity of the scientific method, that when once it has become a habit of mind, that mind converts all facts whatsoever into science. The field of science is unlimited; its material is endless, every group of natural phenomena, every phase of social life, every stage of past or present development is material for science. *The unity of all science consists alone in its method, not in its material* [emphasis original]. The man who classifies facts of any kind whatever, who sees their mutual relation and describes their sequences, is applying the scientific method and is a man of science. The facts may belong to the past history of mankind, to the social statistics of our great cities, to the atmosphere of the most distant stars, to the digestive organs of a worm, or to the life of a scarcely visible bacillus. (Odum, 1924, p. 139).

Vincent (1906) exclaims *all things social* fall under the purview of sociology. By necessity that includes the brain and that includes our phylogeny. Odum (1924), presents Pearson's text to explain that the way to access all things social, is through critical thinking and the scientific method. It took a very long time in sociology's advancement as a discipline to get from *all things social* and use the scientific method to "thou shalt not mention biology or conducteth experiments. Despite a history of investigating all things social, it is not uncommon today to be met with willful-ignorance fueled vitriol if one investigates some things social in some ways.

> Arguably, theories of social *change* have been rather less concerned with the physical facts of human existence. Such efforts as there have been have opened themselves to the charge of biological determinism and have served to antagonize further the relationship between the biological and social sciences. (Pilcher, 1994, p. 484)

In is not uncommon to have the antiquated (and outside of sociology and other niche groups, unknown) term "positivist" hurled in one's direction. Or be accused of "science-ism" for using critical thinking skills, the scientific method, and formal logic. Or best of all, be accosted by the "knights who say 'reductionist'." Being labeled a "reductionist" is especially interesting considering that the scientific method and 400 years of scientific and technological advancement is based squarely on the principle of reduction.

The present study stands as a firm rejection of modern isolationist sociology and in support of the general spirit of *all things social* found in the early years of American sociology. Moving sociological social psychology theory forward, where it concerns human development, the Unified Theory of Development is proposed as a way to collectively build a flexible and viable inductive theory that accounts for *all things social* and all thing that impact *all things social*.

Unified theory of development.

> The use of age in ways which are theoretically informed and empirically rigorous [is] relatively uncharted territory within sociology…[despite] its value in contributing to our understanding of key sociological issues, including the interplay of the biological and the social, the relationship between personal and

> social change and the intersection of biography and history. (Pilcher, 1994, p. 482; citing Finch 1986).

As noted by Gilleard and Higgs (2015), there have been multiple attempts made to reconcile aspects of lifespan psychology and life course sociology. The authors state that over the decades researchers have attempted the linkages between what they perceive of as two levels of analysis by way of social identity theory, narrative experience (biography) (Gilleard and Higgs; 2015). However, Gilleard and Higgs use of Erikson's psychosocial theory of development (for which no empirical support has been achievable) demonstrates a willingness to apply models that feel comfortable over those that best explain the data and are derived from empirical evidences. Instead blending lifespan and life course paradigms will only occur when physiological development and social ecology are coequal in explanatory models of cognition, individual behavior, and collective behavior. Further coequal explanatory power must coalesce in an inductively-derived unified theory that can accommodate advances in our understanding of human social behavior across the lifespan, from whatever quarter those advances may arise. The present study makes a step in a unified direction as basic science from which more nuanced studies and models will be constructed.

The study of adolescence, differences between adolescent and adult behavior, or of transitions between adolescence and adulthood is developmental science—whether undertaken from a sociological, psychological, biological, or conciliatory framework. Despite the many attempts made by some social psychologists (of both flavors) and meso- and macro-level sociologists to integrate biological development and social development into a unified developmental framework, full integration has been largely

unsuccessful. However, renewed vigor for integrative practices is possible in sociology as more practitioners recognize that when considering human behavior, decades of research findings from sociology, psychology, and neuroscience point to an integrated interactional system wherein human phylogeny, ontogenetic processes, and proximal social ecologies all impact on one another. Thus, group-level differences in neural processing of social situations is as important to the social psychologist as is the historical, economic, or social-network drivers for a behavioral response.

One proposed framework for an integrated understanding of human development is the life course tapestry perspective (Crosnoe & Johnson, 2011). Another comparable approach is known as the unified theory of development, which is described by Sameroff (2010) as "a dialectic integration of nature and nurture." The unified theory of development (UTD) can be thought of as both an upgrade to Bronfenbrenner's social ecological model (in that it accounts for biology on a deeper level) and, sociologically, as field theory 2.0 (Lewin, 1939).

Supported by Hegelian and Piagetian theories, UTD views sociological, psychological, and biological explanations for development and behavior as intertwined, and unable to be separated. There is a constant interplay of nature and nurture at all levels of human analysis that cannot be ignored. According to Sameroff (2010), "developmental science requires four models for understanding human growth: *a personal change one, a contextual one, a regulation one, and a representational one*" (emphases original; 2010, p. 12). In other words (a) change through traits, growth, and development at the individual level (biological maturation); (b) social ecology/ context; (c) self- and other-

regulation; and (d) cognitive representations of the world (how one sees the world around them), and the schemas and other cognitive strategies used.

The key is that these four areas are required by developmental science. This is not the same as suggesting that each research study individually address each level of analysis or input. Instead UTD will most likely bear the most fruit when researchers from across disciplines uses empirical evidence from the four areas to build a viable theory within the UTD framework. The present study operates at the level of the brain, but also at the group level (e.g., data is the average response to stimuli), and in response to complex social stimuli. Furthermore, this study is interested in brain responses within the first 300 milliseconds after a stimulus is visible. Neural responses during this short window of time are robust and occur precisely at, or before, a person is consciously aware of the stimulus (Madl, Baars, & Franklin, 2011). Thus, while the present basic research does not address each area of UTD, it provides a specific understanding of developmental differences that can inform how the model is applied and how future research is developed—just as ethnographic research on peer groups at middle schools would do.

> …an increasing proportion of [adolescence] research now places the biological, cognitive, and emotional development of adolescents in a broader social context…[t]he changing orientation of adolescent research is in part a function of the breakdown of traditional barriers between fields. Outstanding developmental psychologists now perceive adolescence as occurring in historical, social, organizational, cultural, and institutional contexts. (Dornbusch, 1989, p. 233)

The sociological social psychology literature can provide nuance to UTD's dialectal model not otherwise achievable, however, only if the personal change model is accepted by sociologists as coequal and factored into current models that over-emphasize social context. Incorporating the biological level is not a new path for sociology, simply a forgotten one. Beginning well before sociology was separate from social philosophy, calls have been repeatedly made for integration of evidences from sociology, psychology, and biology to truly understand human social and cooperative behavior (Ward, 1895; Means, 1967; van den Berghe, 1990; Udry, 1995; Freese, Jui-Chung, & Wade, 2003; McCutcheon, V. V., 2006). It is time to again investigate *all things social*, and to explore forgotten methods and new technologies with which to accomplish that goal. This study is as much a study of intergroup bias as it is a step in that direction.

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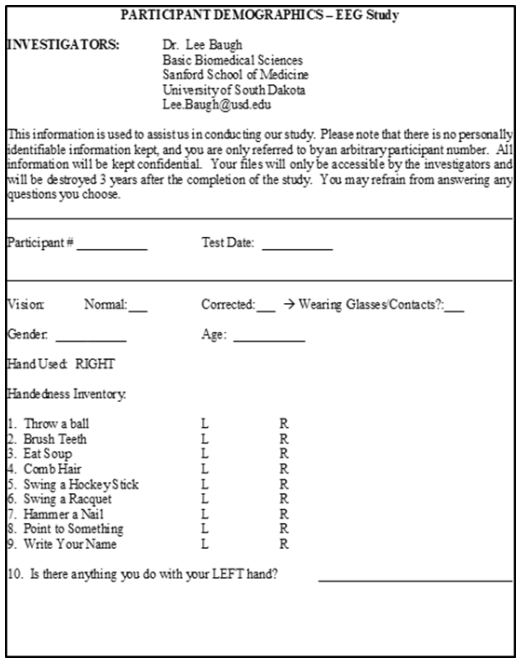
Appendix A: Participant Forms



PARTICIPANT DEMOGRAPHICS – EEG Study

INVESTIGATORS: Dr. Lee Baugh
Basic Biomedical Sciences
Sanford School of Medicine
University of South Dakota
Lee.Baugh@usd.edu

This information is used to assist us in conducting our study. Please note that there is no personally identifiable information kept, and you are only referred to by an arbitrary participant number. All information will be kept confidential. Your files will only be accessible by the investigators and will be destroyed 3 years after the completion of the study. You may refrain from answering any questions you choose.

Participant # _____ Test Date: _____

Vision: Normal:___ Corrected:___ → Wearing Glasses/Contacts?:___

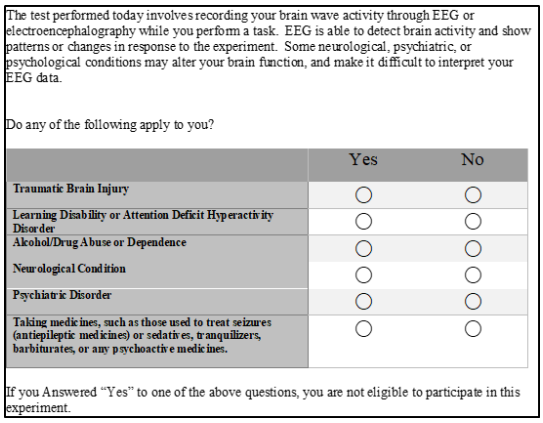
Gender: _____ Age: _____

Hand Used: RIGHT

Handedness Inventory:

1. Throw a ball	L	R
2. Brush Teeth	L	R
3. Eat Soup	L	R
4. Comb Hair	L	R
5. Swing a Hockey Stick	L	R
6. Swing a Racquet	L	R
7. Hammer a Nail	L	R
8. Point to Something	L	R
9. Write Your Name	L	R

10. Is there anything you do with your LEFT hand? _____



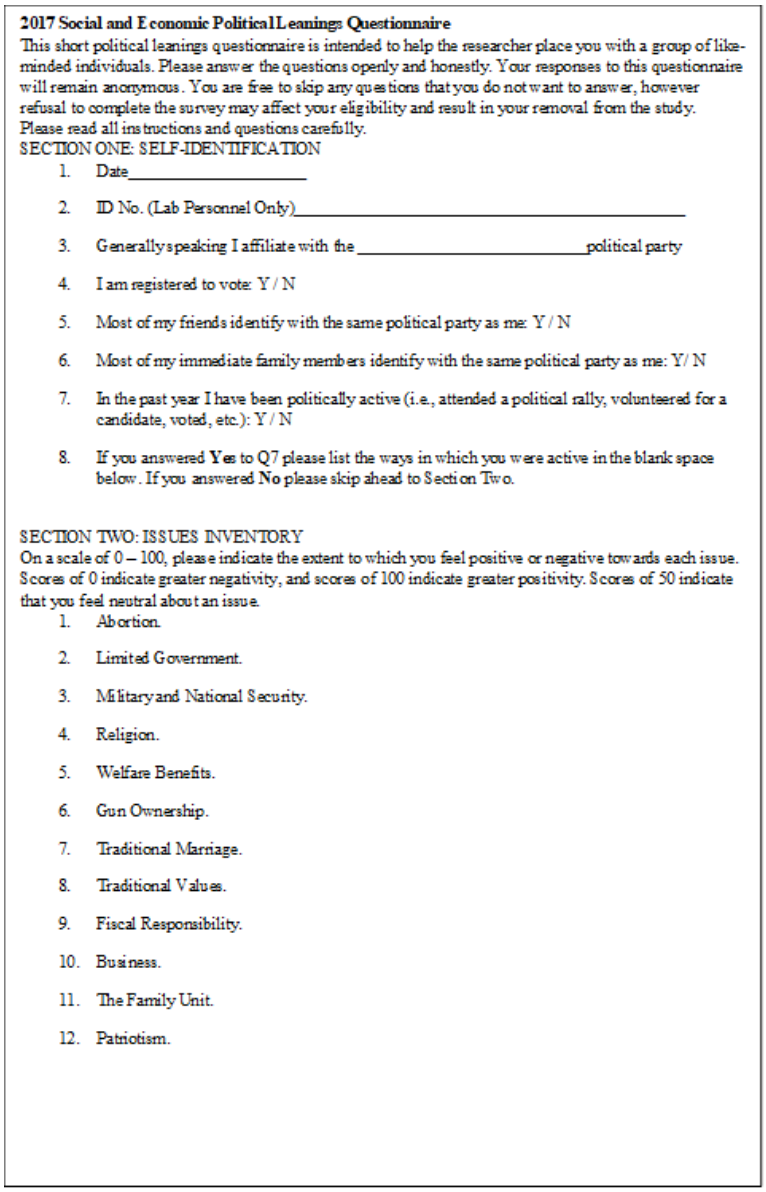
The test performed today involves recording your brain wave activity through EEG or electroencephalography while you perform a task. EEG is able to detect brain activity and show patterns or changes in response to the experiment. Some neurological, psychiatric, or psychological conditions may alter your brain function, and make it difficult to interpret your EEG data.

Do any of the following apply to you?

	Yes	No
Traumatic Brain Injury	○	○
Learning Disability or Attention Deficit Hyperactivity Disorder	○	○
Alcohol/Drug Abuse or Dependence	○	○
Neurological Condition	○	○
Psychiatric Disorder	○	○
Taking medicines, such as those used to treat seizures (antiepileptic medicines) or sedatives, tranquilizers, barbiturates, or any psychoactive medicines.	○	○

If you Answered "Yes" to one of the above questions, you are not eligible to participate in this experiment.

Figure 26. Participant demographics form. Side one (left) contains visual acuity, gender, and handedness. Side two (right) is the limited medical history.



2017 Social and Economic Political Leanings Questionnaire

This short political leanings questionnaire is intended to help the researcher place you with a group of like-minded individuals. Please answer the questions openly and honestly. Your responses to this questionnaire will remain anonymous. You are free to skip any questions that you do not want to answer, however refusal to complete the survey may affect your eligibility and result in your removal from the study. Please read all instructions and questions carefully.

SECTION ONE: SELF-IDENTIFICATION

1. Date_____
2. ID No. (Lab Personnel Only)_____
3. Generally speaking I affiliate with the _____political party
4. I am registered to vote: Y / N
5. Most of my friends identify with the same political party as me: Y / N
6. Most of my immediate family members identify with the same political party as me: Y/ N
7. In the past year I have been politically active (i.e., attended a political rally, volunteered for a candidate, voted, etc.): Y / N
8. If you answered **Yes** to Q7 please list the ways in which you were active in the blank space below. If you answered **No** please skip ahead to Section Two.

SECTION TWO: ISSUES INVENTORY

On a scale of 0 – 100, please indicate the extent to which you feel positive or negative towards each issue. Scores of 0 indicate greater negativity, and scores of 100 indicate greater positivity. Scores of 50 indicate that you feel neutral about an issue.

1. Abortion.
2. Limited Government.
3. Military and National Security.
4. Religion.
5. Welfare Benefits.
6. Gun Ownership.
7. Traditional Marriage.
8. Traditional Values.
9. Fiscal Responsibility.
10. Business.
11. The Family Unit.
12. Patriotism.

Figure 27. 2017 Social and Economic Political Leanings Questionnaire. Side one of the questionnaires corresponds to section one and preceding instructions. Side two (*Issues Inventory*) is the 12-item Social and Economic Conservativism Scale (SECS; Everett, 2013). Subjects completed the two questionnaires (presented on front and back of a single sheet of paper) as the first task of the behavioral training session.

Exit Questionnaire
EEG/Behavioral Testing

Research Subject Identifier:_____
Date:_____

Thank you for participating in our study. We would appreciate it if you would answer the following questions about your experience.

1) Did you experience any unusual sensations participating in this study?
Yes ☐ No ☐
If yes, please describe (what, when, how long)
_____
_____

2) Please check the following:

Did you experience the following	YES	NO
a) nervousness	☐	☐
b) frustration	☐	☐
c) boredom	☐	☐
d) fatigue	☐	☐
e) headache	☐	☐
f) pain	☐	☐
g) skin irritation	☐	☐

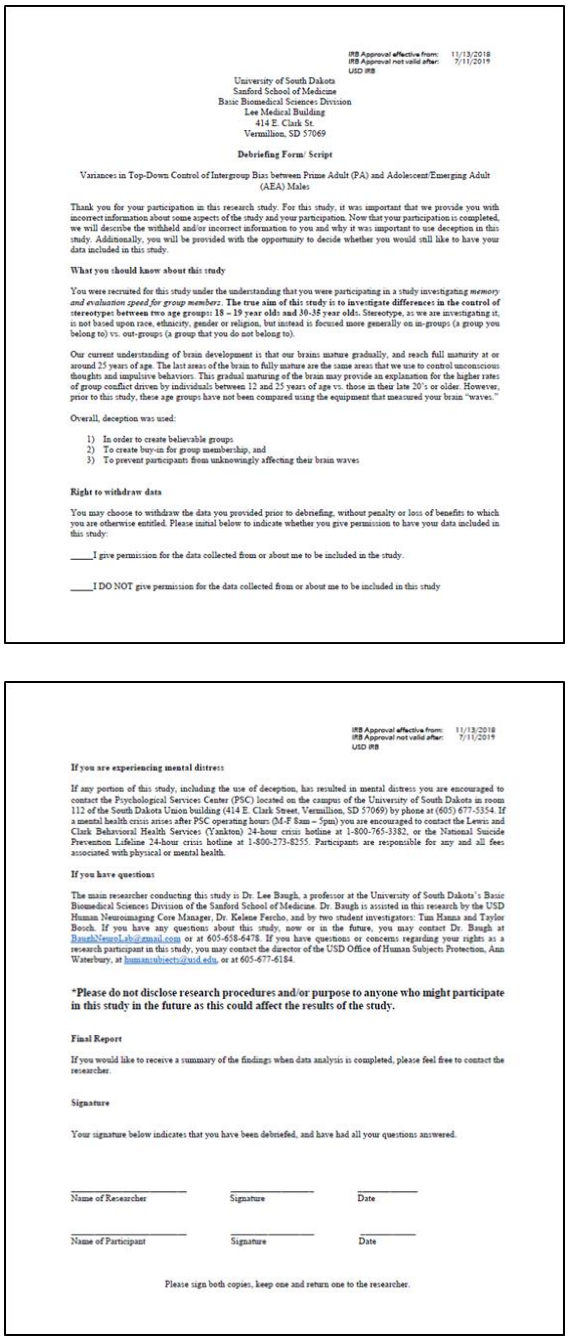
Comments:_____

	YES	NO
3) Would you participate in a similar study again?	☐	☐
Would you like to be contacted when you are eligible for another study?	☐	☐

4) Please tell us how we could have made your experience more comfortable
_____
_____

5) How did you feel about the way in which you were approached about participating in this study
_____

Figure 28. Study exit questionnaire. This questionnaire was given to subjects to fill out at the end of experimental testing, but prior to deception debriefing and the reconsent process.



IRB Approval effective from: 11/13/2018
IRB Approval not valid after: 7/11/2019
USD IRB

University of South Dakota
Sanford School of Medicine
Basic Biomedical Sciences Division
Lee Medical Building
414 E. Clark St.
Vermillion, SD 57069

Debriefing Form/ Script

Variances in Top-Down Control of Intergroup Bias between Prime Adult (PA) and Adolescent/Emerging Adult (AEA) Males

Thank you for your participation in this research study. For this study, it was important that we provide you with incorrect information about some aspects of the study and your participation. Now that your participation is completed, we will describe the withheld and/or incorrect information to you and why it was important to use deception in this study. Additionally, you will be provided with the opportunity to decide whether you would still like to have your data included in this study.

What you should know about this study

You were recruited for this study under the understanding that you were participating in a study investigating *memory and evaluation speed for group members*. **The true aim of this study is to investigate differences in the control of stereotypes between two age groups: 18 – 19 year olds and 30-35 year olds.** Stereotype, as we are investigating it, is not based upon race, ethnicity, gender or religion, but instead is focused more generally on in-groups (a group you belong to) vs. out-groups (a group that you do not belong to).

Our current understanding of brain development is that our brains mature gradually, and reach full maturity at or around 25 years of age. The last areas of the brain to fully mature are the same areas that we use to control unconscious thoughts and impulsive behaviors. This gradual maturing of the brain may provide an explanation for the higher rates of group conflict driven by individuals between 12 and 25 years of age vs. those in their late 20's or older. However, prior to this study, these age groups have not been compared using the equipment that measured your brain "waves."

Overall, deception was used:

1) In order to create believable groups
2) To create buy-in for group membership, and
3) To prevent participants from unknowingly affecting their brain waves

Right to withdraw data

You may choose to withdraw the data you provided prior to debriefing, without penalty or loss of benefits to which you are otherwise entitled. Please initial below to indicate whether you give permission to have your data included in this study:

_____I give permission for the data collected from or about me to be included in the study.

_____I DO NOT give permission for the data collected from or about me to be included in this study

IRB Approval effective from: 11/13/2018
IRB Approval not valid after: 7/11/2019
USD IRB

If you are experiencing mental distress

If any portion of this study, including the use of deception, has resulted in mental distress you are encouraged to contact the Psychological Services Center (PSC) located on the campus of the University of South Dakota in room 112 of the South Dakota Union building (414 E. Clark Street, Vermillion, SD 57069) by phone at (605) 677-5354. If a mental health crisis arises after PSC operating hours (M-F 8am – 5pm) you are encouraged to contact the Lewis and Clark Behavioral Health Services (Yankton) 24-hour crisis hotline at 1-800-765-3382, or the National Suicide Prevention Lifeline 24-hour crisis hotline at 1-800-273-8255. Participants are responsible for any and all fees associated with physical or mental health.

If you have questions

The main researcher conducting this study is Dr. Lee Baugh, a professor at the University of South Dakota's Basic Biomedical Sciences Division of the Sanford School of Medicine. Dr. Baugh is assisted in this research by the USD Human Neuroimaging Core Manager, Dr. Kelene Fercho, and by two student investigators: Tim Hanna and Taylor Bosch. If you have any questions about this study, now or in the future, you may contact Dr. Baugh at BaughNeuroLab@gmail.com or at 605-658-6478. If you have questions or concerns regarding your rights as a research participant in this study, you may contact the director of the USD Office of Human Subjects Protection, Ann Waterbury, at humansubjects@usd.edu, or at 605-677-6184.

***Please do not disclose research procedures and/or purpose to anyone who might participate in this study in the future as this could affect the results of the study.**

Final Report

If you would like to receive a summary of the findings when data analysis is completed, please feel free to contact the researcher.

Signature

Your signature below indicates that you have been debriefed, and have had all your questions answered.

Name of Researcher	Signature	Date
Name of Participant	Signature	Date

Please sign both copies, keep one and return one to the researcher.

Figure 29. Deception debriefing. This form was used to reveal the deception condition to participants, explain where deception occurred, why it was used, and what the true nature of the study was. Subjects were reconsented in order to use their data at the end of the debriefing.

Appendix B: Recruitment

Screen-shots of the Sona recruitment page that was visible to students for Part 1 (behavioral training) and Part 2 (experimental testing) are provided. Additionally, the general recruitment flyer, as well as flyers specifically targeting the 30–35-year-old population in both recruitment locations are provided. The general recruitment flyer shown here was the third iteration of the flyer approved for use. In each iteration the content largely remained the same and only the placement and coloration were modified to increase visibility. The two targeted recruitment flyers are identical to one another except for recruitment-region specific testing location information. Additionally, the targeted flyer content is the same as the general flyer except that references to the adolescent group are removed and the age-range sought is prominently placed in the design.

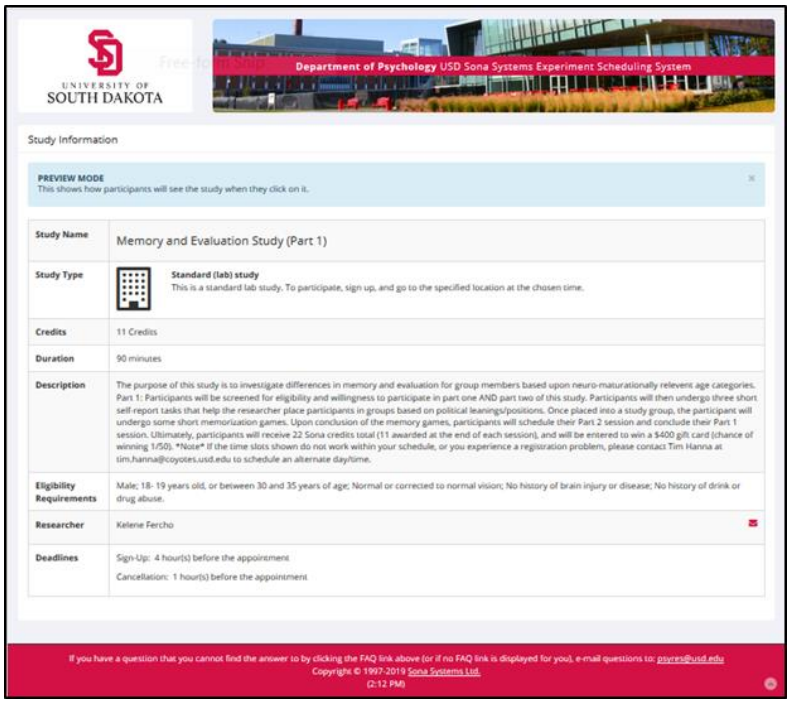


Figure 30. Sona recruitment advertisement (participant view) for behavioral training enrollment (Part 1)

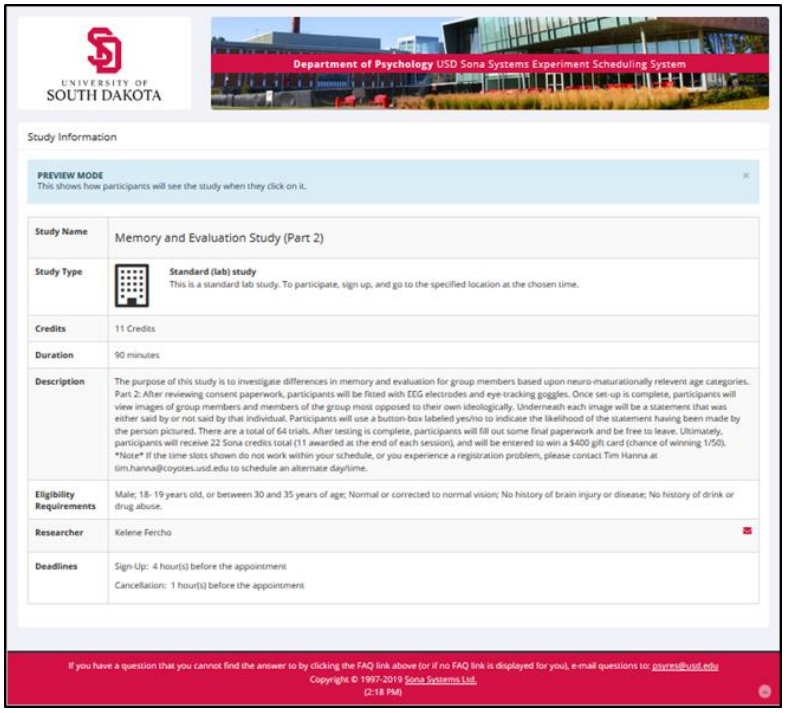


Figure 31. Sona recruitment advertisement (participant view) for experimental testing enrollment (Part 2). Subjects did not self-enroll for testing, but scheduled with the researcher.

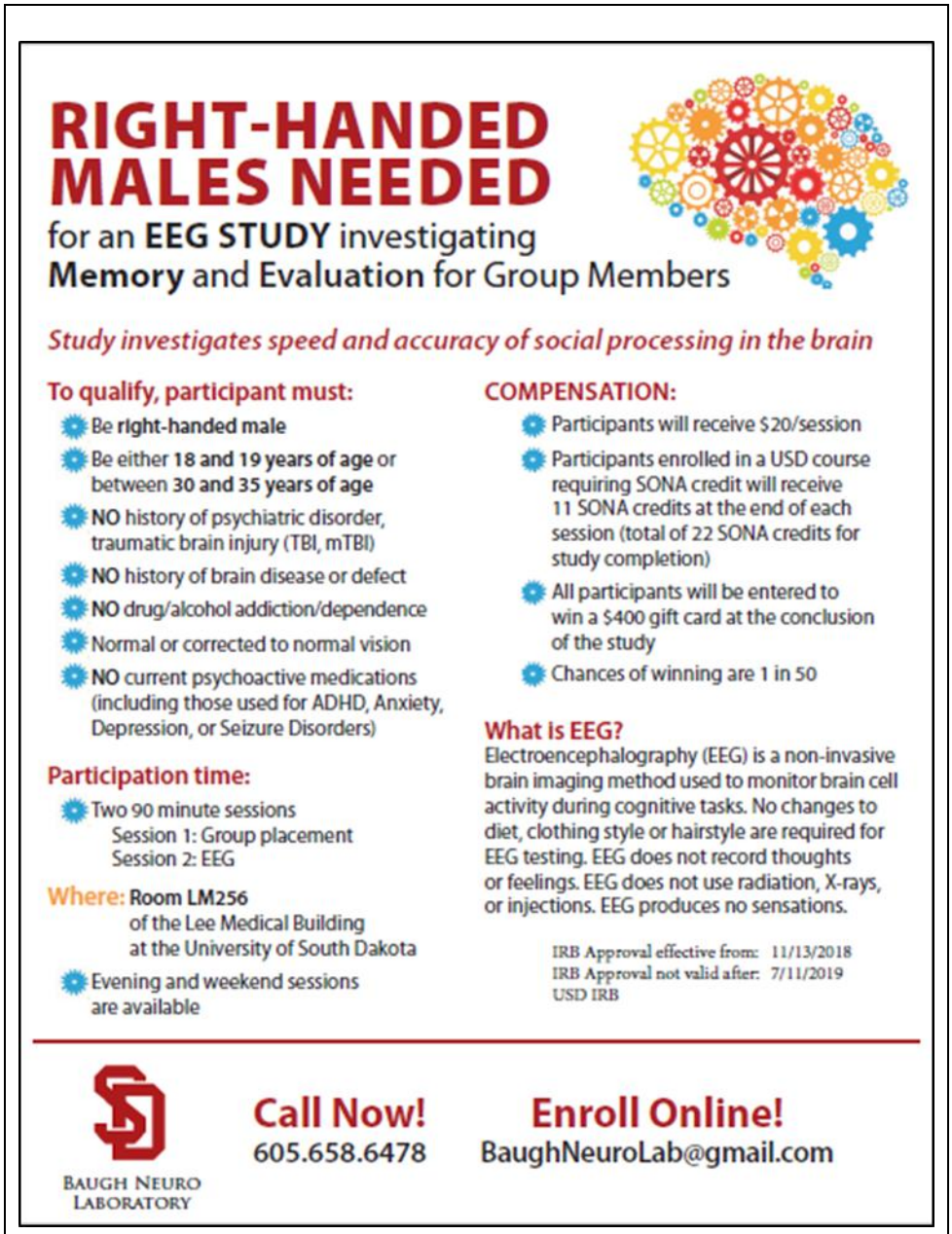


Figure 32. Version number three of the study recruitment flyer.

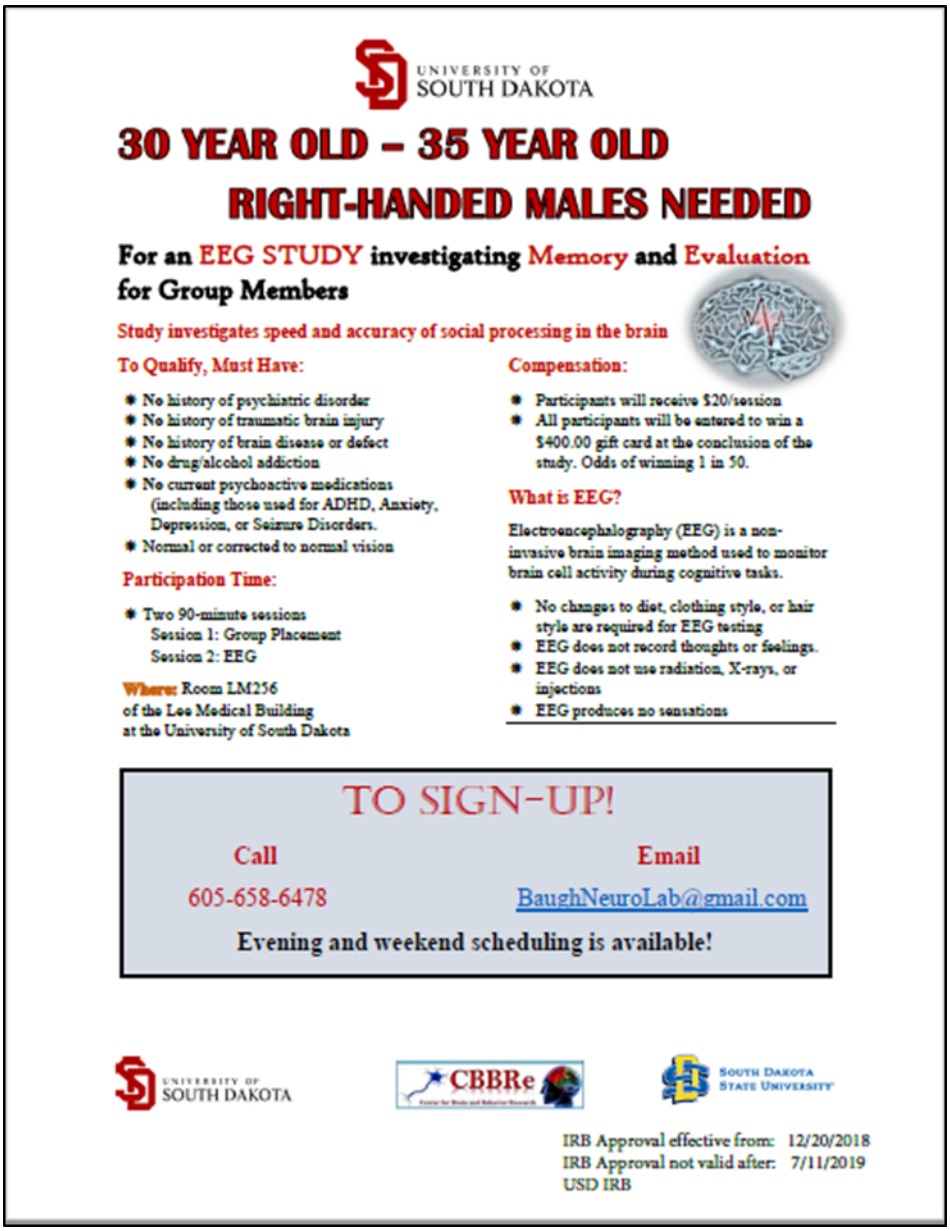


Figure 33. Study recruitment flyer targeting 30- through 35-year-old males in the Vermillion/Yankton SD area.

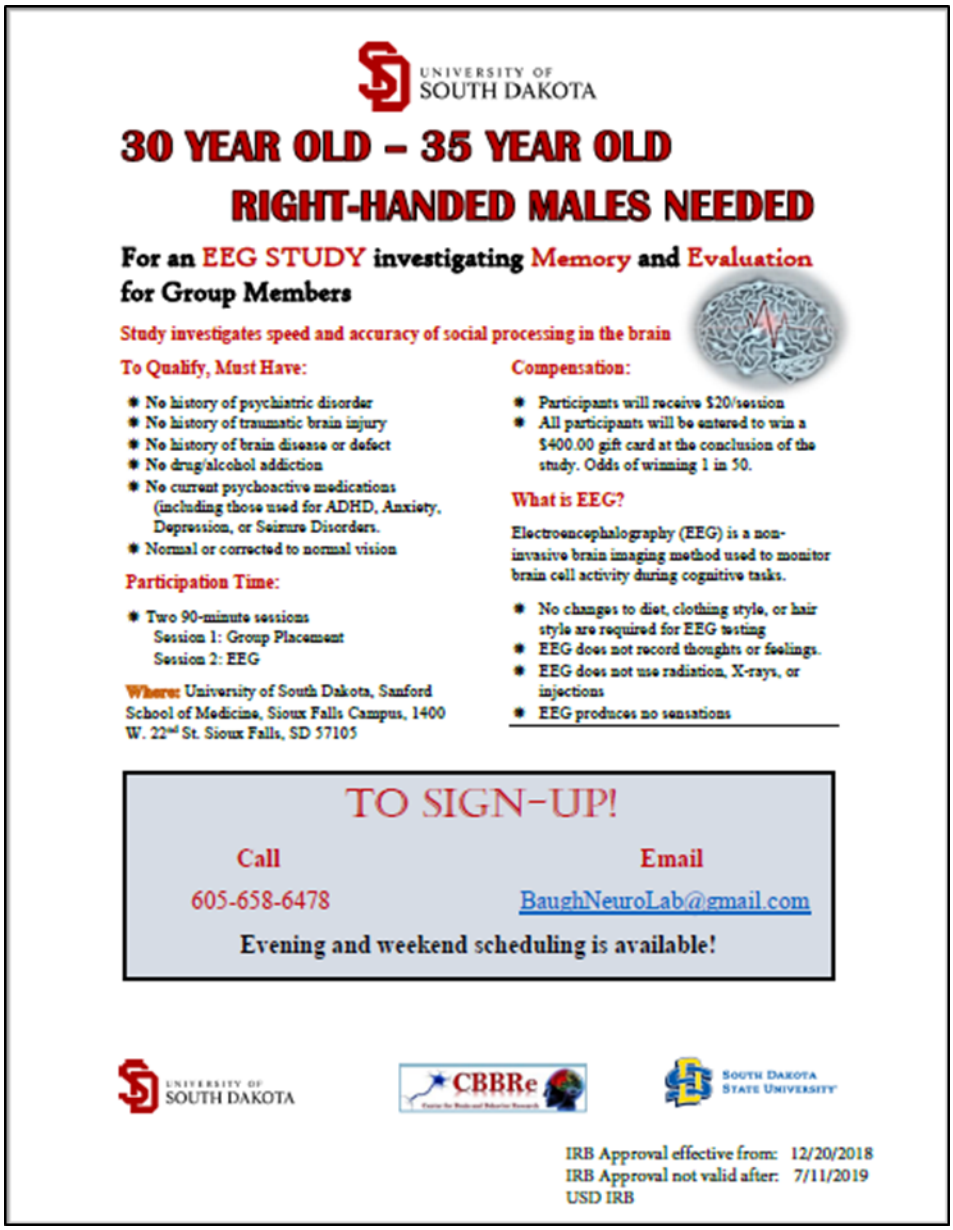


Figure 34. Study recruitment flyer targeting 30- through 35-year-old males in the Sioux Falls, SD area.

Appendix C: EEG/ERP Processing

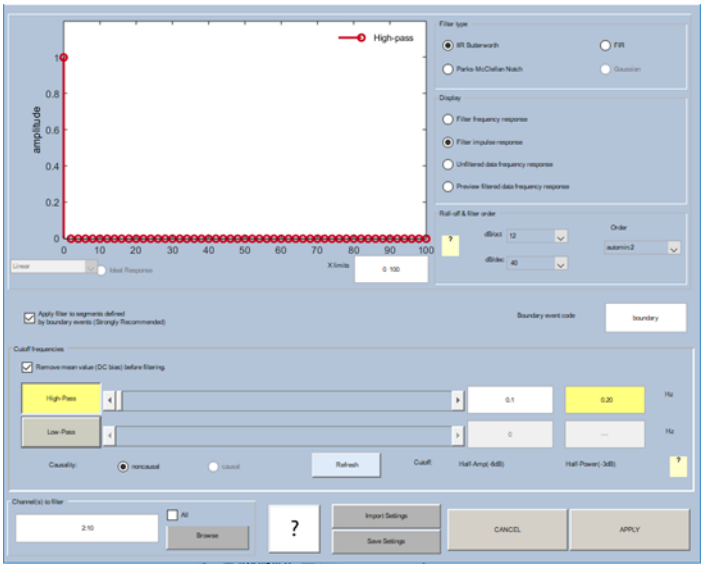


Figure 35. ERPLAB High-Pass Filter settings. Noncausal IIR Butterworth 0.1 Hz 12dB/oct with DC bias removed prior to filtering. Filter was applied to channels F4,Fz,F3;C4,Cz,C3;P4,Pz,P3.

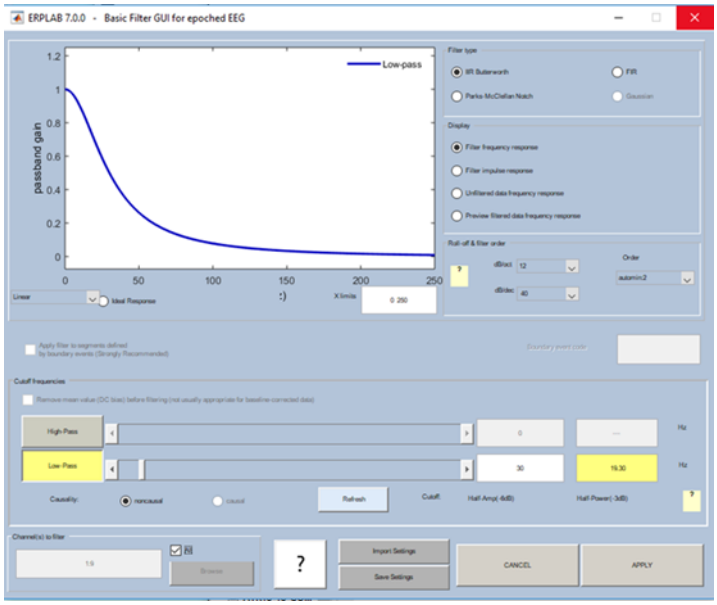


Figure 36. ERPLAB Low-Pass Filter settings. Noncausal IIR Butterworth 30 Hz 12dB/oct. Filter was applied to channels F4,Fz,F3;C4,Cz,C3;P4,Pz,P3.

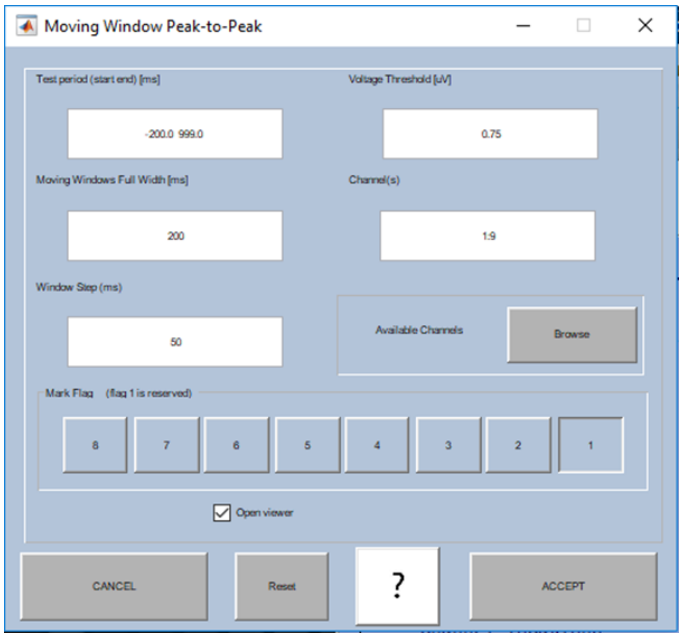


Figure 37. ERPLAB moving window peak-to-peak artifact detection settings. Voltage threshold was reduced to account for the extremely low amplitudes recorded.

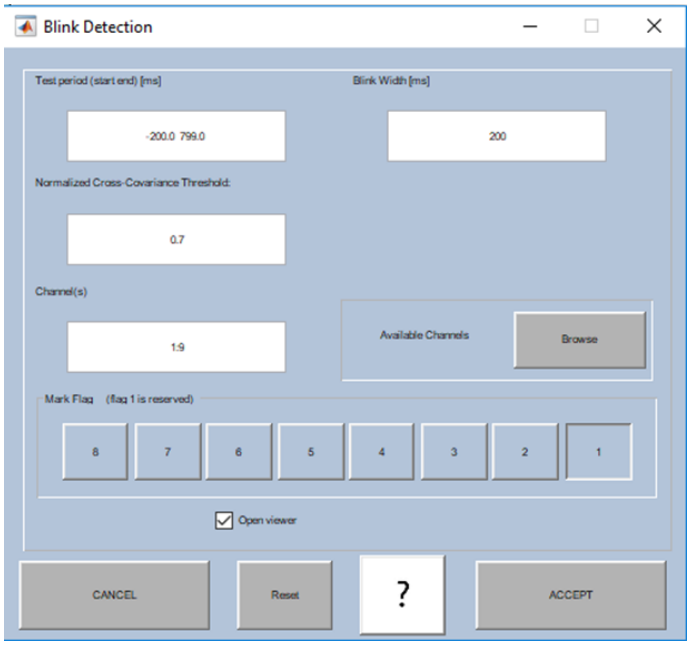


Figure 38. ERPLAB blink detection (beta) artifact detection settings.

Appendix D: ERP Traces for Above-Chance Subjects

The ERP traces that appear in this appendix are for group-level comparisons between the adult group (30–35-year-old subjects) and members of the adolescent group (18 – 19-year-old subjects) that performed at the above chance threshold of .64 when accounting for hits, misses, false alarms, and correct rejections. Traces are for main effects of group and congruency at electrodes Fz, Cz, Pz, and represent correct trials only. As a reminder, comparisons between ERPs for above-chance performers and below-chance performers revealed that separation of the two performance levels was not justified. This is likely due to the presence of no-response data. Because the reason for the no-response is unknown (abstention vs. timing) these data were not factored. As a result, performance levels may have been significantly better than the data reveled (based upon the similarity of response). The traces presented below do not represent data that were analyzed further. These data are presented for transparency purposes only. Categories and stimuli are the same as they were for data presented in the body and group information is discussed in the method section. All ERP grand-averaging takes place after subject removal or data rejection (if needed). Therefore, these data have the same attrition as the combined performance data with the exception that they also do not include a subsample based upon performance.

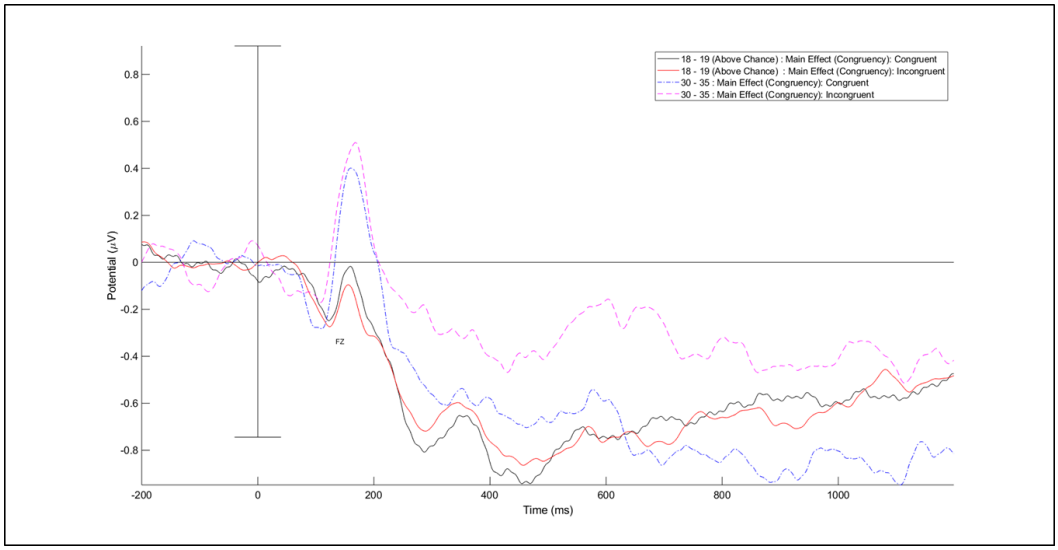


Figure 39. Above chance adolescents vs. adult group Main effects for congruency (congruent vs. incongruent). Recorded at electrode Fz.

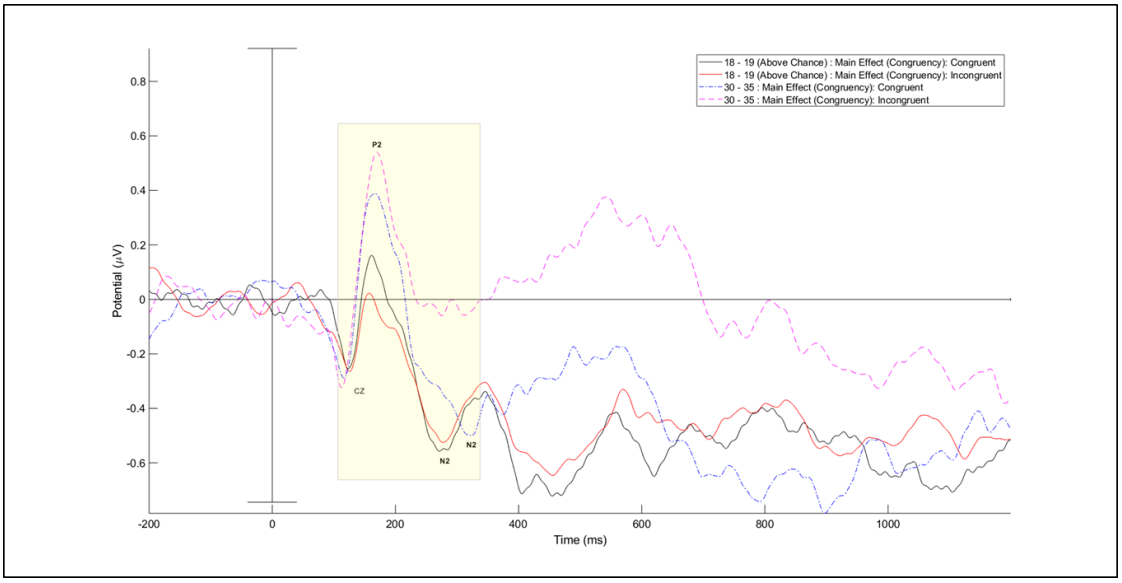


Figure 40. Above chance adolescents vs. adult group. Main effects for congruency (congruent vs. incongruent). Recorded at electrode Cz.

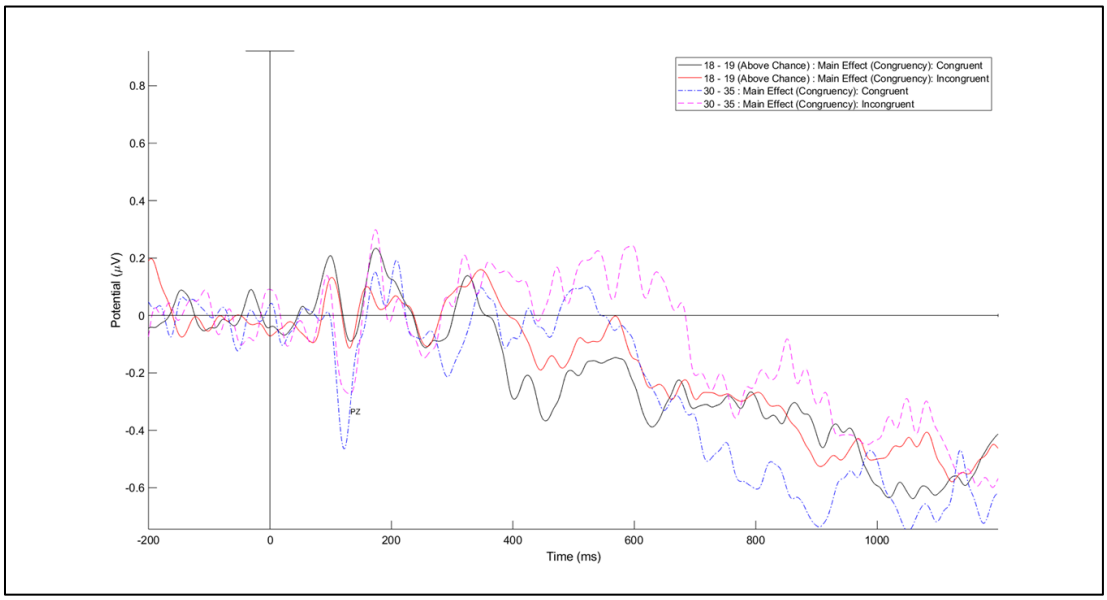


Figure 41. Above chance adolescents vs. adult group. Main effects for congruency (congruent vs. incongruent). Recorded at electrode Pz.

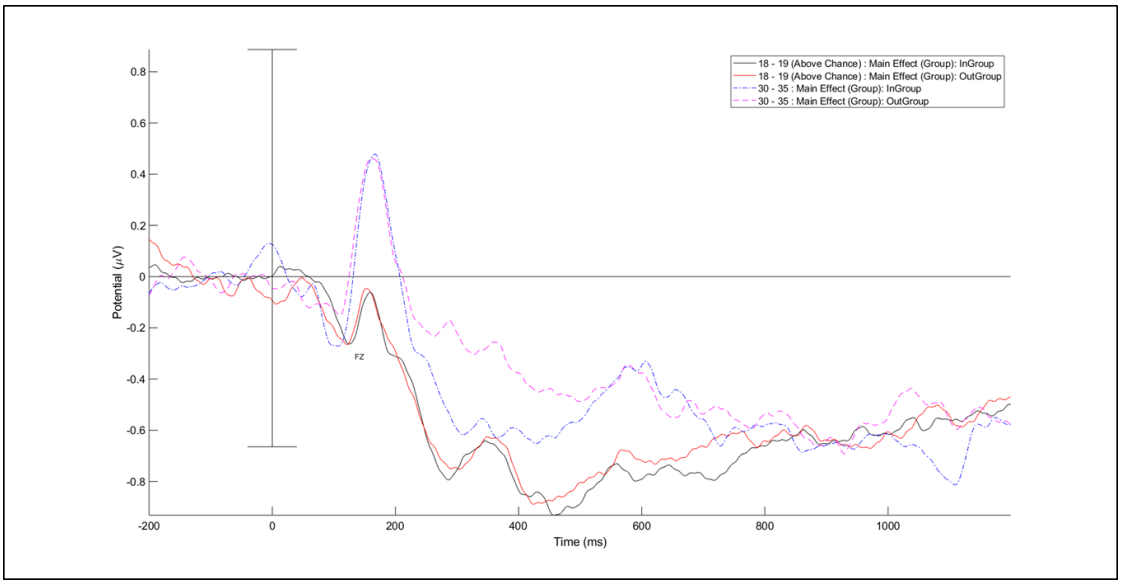


Figure 42. Above chance adolescents vs. adult group. Main effects for group (ingroup vs. outgroup). Recorded at electrode Fz.

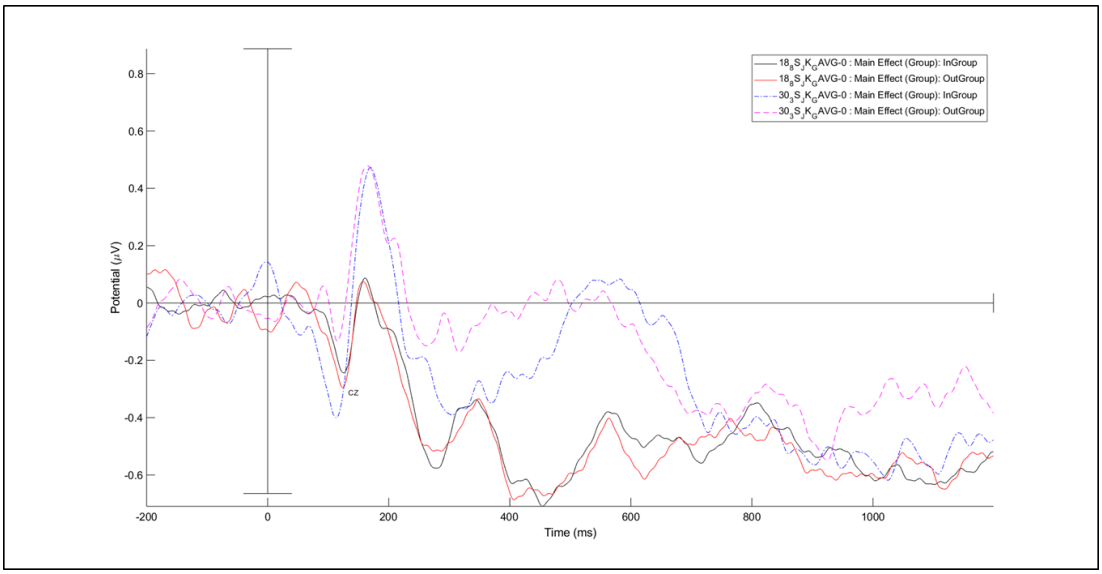


Figure 43. Above chance adolescents vs. adult group. Main effects for group (ingroup vs. outgroup). Recorded at electrode Cz.

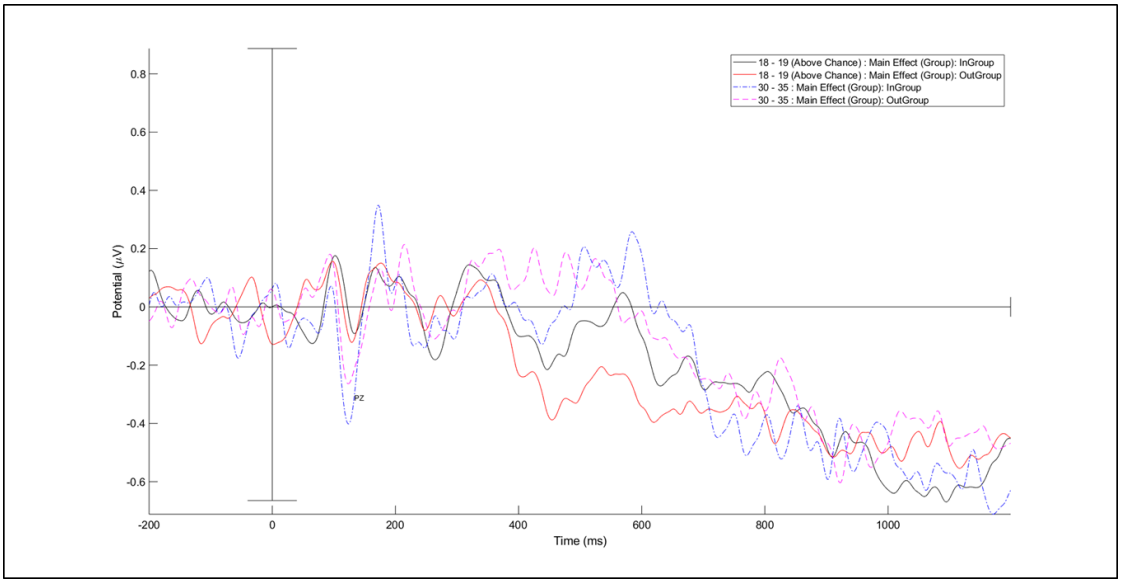


Figure 44. Above chance adolescents vs. adult group. Main effects for group (ingroup vs. outgroup). Recorded at electrode Pz.

Appendix E: Stereotype Phrases

List of stereotype phrases for stimuli. These were derived from information presented as stereotypes for political-liberals and -conservatives as a part of a summer 2017 social problems course (Soc 205) offered at Eastern Oregon University by sociology professor Bill Grigsby. The webpage can be found at https://people.eou.edu/socprob/readings/week-2/liberal-vs-conservative/. Prof. Grigsby was not consulted or contacted for the creation of the stereotype stimuli listings. Phrases were positively worded to account for confounds from mixed wording styles. For example, "Supports Limited Government" "Supports Large Government." Areas covered include the environment, war, poverty, government (role of), crime, and morality. These phrases appeared below stimulus images.

Conservative

- Supports Personal Responsibility
- Less Government Oversight is Best
- Supports Fewer Regulations for Businesses
- Poverty is Directly Related to Work-Ethic
- Government Environmental Regulations Effect Economic Development
- The Earth Goes Through Natural Cycles of Global Warming and Climate Change Regardless of Human Activity
- War is Necessary When American Values are Threatened
- Immigration Weakens our Country
- Criminals Should Receive Strict Sentencing
- Supports Free Trade

- Torture is Sometimes Necessary
- America Does More Good than Harm Around the World
- Privacy is More Important than Security
- Liberals are Socialists that Legislate Morality
- American Ideals and Values are Judeo-Christian
- Pro-Life
- Religion is Important in Government
- Legal System is Fair
- Gays and Lesbians Make Choices that Don't Merit Constitutional Protection
- The Overall Morality of Our Culture is Declining

Liberal

- Supports Social Programs
- More Government Oversight is Best
- Supports More Regulations for Businesses
- Poverty is Directly Related to Structural Barriers
- Government Should Protect Citizens from Environmental Threats
- Human Activity is Causing Global Warming and Climate Change
- Diplomacy is Always the Best Course of Action
- Immigration Strengthens our Country
- Criminals Should Be Given Reform Opportunities Instead of Incarceration
- Supports Fair Trade
- America Does More Harm than Good Around the World
- Security is More Important than Privacy

- Conservatives are America's Taliban
- American Ideals and Values are Pluralistic
- Pro-Choice
- Church and State Should Remain Separated
- Legal System is Racist
- The Constitution Recognizes the Equality of All Americans, Regardless of Sexual Orientation
- The Overall Morality of Our Culture is Improving