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Substance Misuse Transitions Between Adolescence and Young Adulthood: Impacts on Young Adult Self-Sufficiency

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SUBSTANCE MISUSE TRANSITIONS BETWEEN ADOLESCENCE AND YOUNG ADULTHOOD: IMPACTS ON YOUNG ADULT SELF-SUFFICIENCY

by

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ABSTRACT

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Substance use typically initiates during adolescence, peaks during emerging adulthood, and decreases by young adulthood. Misuse, the use of substances in manner, situation, amount, or frequency that can be harmful to self or other, is prevalent as individuals' transition into adulthood. This trend in substance misuse coincides with sensitive developmental periods preparatory to taking on adult roles. The extent to which substance misuse influences young adult developmental outcomes is unclear. This research used a life course theory lens to explore the impact of substance misuse patterns on young adult self-sufficiency outcomes. Specifically, Matured-Out, Continuing Users, and Stable Normative patterns of use were explored for their association with young adult self-sufficiency. Furthermore, a Continuing-Cannabis profile was separated to explore difference in outcomes between substance use patterns. Using an accelerated cohort design, the National Longitudinal Study of Adolescent Health was utilized to explore the

impact of patterns of substance misuse on young adult self-sufficiency outcomes. The Add Health data spanned adolescent (13 to 17 years old, N = 15,400), emerging adult (18 to 25, N = 16,749), and young adult (26 to 33, N = 15,632) developmental periods. Latent profile analyses (LPA) for substance misuse were conducted at each developmental period. The cross-sectional LPAs were combined in a longitudinal mixture model (LMM) to identify patterns of transition in substance misuse. The numerous substance use trajectories were consolidated into three (and then four) theoretically relevant substance use patterns in a mover stayer (MS) model. Young adult self-sufficiency outcomes were compared between patterns defined by some misuse (Matures-Out, and Continuing Users [which was further separated into Continuing-Cannabis and Continuing Illicit MS profiles]) and the pattern defined by minimal misuse (the Stable Normative MS profile). Significant differences in young adult self-sufficiency outcomes were identified between the Stable Normative MS profile and Continuing-Users (both Continuing-Cannabis and Continuing-Illicit profiles) such that members in the Continuing-Users MS profiles achieved lower levels of young adult personal autonomy, responsibility, and financial independence. Matured-Out and Continuing Users profiles were also associated with varying educational, event-based milestones, and self-perceived development compared to the Stable Normative profile. Research and policy implications are discussed.

(275 pages)

PUBLIC ABSTRACT

Substance Misuse Transitions Between Adolescence and Young Adulthood: Impacts on Young Adult Self-Sufficiency

Amanda M. Hagman

Substance misuse during the transition to adulthood can be problematic, but it is also socially celebrated. There can be negative short-term impacts associated with intoxication, but are there negative long-term impacts of substance misuse on the transition into adulthood?

Let us pause for a moment. Many individuals may have just glazed over thinking, "Adulthood? I'm not doing that any time soon." But when you consider what qualifies individuals as adults, this research may seem more pertinent. Adults make their own choices. Adults take responsibility for those choices. Adults are financially independent. So, while the notion of adulthood may conjure images of the suburbs and stability, adulthood as actually the ability to be self-sufficient. Something we are all working towards.

This research looked at the young adult self-sufficiency outcomes between individuals who have patterns of substance misuse as they transition to adulthood and those who had minimal misuse. Specifically, we considered individuals who Matured-Out of substance use and individuals who continued to use. Continuing users were further divided into Continuing-Cannabis or Continuing-Illicit patterns.

For the most part, those who Matured-Out by young adulthood had similar

developmental outcomes compared to those who did not misuse substances during the transition to adulthood. Those who continued to use cannabis or illicit substances into young adulthood, however, were less self-sufficient as young adults.

These findings have important implications for policies that promote cannabis legalization. As cannabis becomes increasingly available, policymakers and community leaders should have an eye on providing the necessary supports to help young adults gain self-sufficiency regardless of legalization status.

DEDICATION

To Trent Hagman, you are the rock of all that is important to me. To Beck, Sloane, and Soren, you motivate me with your energy for life. To my parents, you opened the world to me and let me believe my opportunities were boundless. To Jim, Jessica, and Parker, you provided me with the support and competitive edge that can only come from siblings. To Donna Graham Maughan, Kris Nelson Maughan, Lois Lilly Graham, Mae Lilly, Alta Lilly, and Lenice Lilly (and the other women and men who progressed women's rights), you recognized the value of education for women in a time when the opportunities were scarce and unpopular. To the friends and family who encouraged my persistence—thank you.

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CHAPTER 1

INTRODUCTION

Overview of Research

Statement of Problem

Substance misuse, the use of alcohol or drugs in a manner, situation, amount, or frequency that could cause harm to the user or to those around them (U.S. Department of Health and Human Services, 2016), is a major public health concern. Its impact can be felt at the community, familial, and individual level. Economists estimate the societal costs of substance abuse to be near $484 billion per year in the U.S. (Sacks et al., 2015; U.S. Department of Justice, 2011). It is more difficult to quantify the impact of substance misuse at the individual and familial level, it can be partially described in the exposure to risks associated with substance misuse: poisoning, accidental injury (of self or others), physical or sexual assault, child neglect, domestic violence, and legal problems (Collins & Spencer, 1999; Rehm et al., 2014). Despite the high societal costs and personal risk associated with substance misuse, the prevalence of annual substance misuse in the general population remains relatively common in the U.S.; 25.4% of individuals exhibited alcohol misuse and 25.8% endorse illegal substance use in the past month (Schulenberg et al., 2019).

The high prevalence of misuse in the general population is associated with deleterious effects. In 2017, approximately 70,237 American citizens died from an overdose; in 1999 there were 16,849 overdose deaths. The change between 1999 and 2017 represents over a twofold increase in overdose-related deaths in less than two

decades (National Institute on Drug Abuse, 2020). Outside of overdose deaths, many more must live with chronic substance use disorders and associated health concerns. Substance misuse accounts for a significant proportion of the global disease burden; it is associated with an increased risk of both communicable and noncommunicable diseases (World Health Organization, 2018).

Given that substance misuse is associated with negative outcomes, it has been established as a main priority of the government through the Office of the Surgeon General. Initiatives are directed towards ameliorating the negative outcomes associated with substance misuse through policy, research, and supply and demand reduction (U.S. Department of Health and Human Services [HHS], 2016). Initiatives seek to control both licit and illicit substance misuse. Most resources are allocated to supply reduction; that is, to monitoring and control for licit substances and suppression and disruption of production and distribution channels for illicit substances. However, in recent years substantially more attention has been directed towards demand reduction, which targets the prevention and treatment of substance misuse. Indeed, demand drives the supply. An essential element of demand reduction is to intervene on individual motivations to initiate or continue use. Research plays an integral part in demand reduction.

As part of the priority to reduce substance misuse, the U.S. has faithfully tracked attitudes towards and trends of misuse for decades (Schulenberg et al., 2019). Briefly, results from trend analyses depict initiation of substance misuse starting in the middle of the second decade of life (referred to as adolescence; 13 to 17 years of age), peaking during the early third decade of life (referred to as emerging adulthood; 18 to 25 years of

age), and declining in the late third decade of life (referred to as young adulthood; 26 to 32 years of age). Interestingly, and even though at any given time nearly 25% of the population engages in substance misuse, most terminate misuse behaviors by young adulthood without notable difficulty (Chen & Kendel, 1995; Labouvie, 1996; Stall & Biernacki, 1986; Winick, 1962). In the literature, this is called natural recovery, spontaneous recovery, self-change, aging out, or maturing out of substance misuse; this research gives preference to the term maturing out as the term is most often used in developmental research.

The trend to mature out of substance misuse has led some to see experimental or heavy use as a rite of passage during adolescence and emerging adulthood (Crawford & Novak, 2006; Schulenberg & Maggs, 2002). Many individuals even cite prosocial motives for substance misuse behaviors, despite the personal risks and costs associated with behaviors (Patrick & Schulenberg, 2014; Terry-McElrath et al., 2009). While the subject of substance misuse can become bias laden (Smith et al., 2011), the reality is that some substance misuse is common and mostly accepted by peers starting in adolescence and increasing during emerging adulthood (Borsari & Carey, 2001; Parker et al., 2002; Schulenberg et al., 2019). It is also true, however, that research on substance misuse spanning the transition to adulthood is still emergent. Long-term psychosocial impacts of substance misuse are still relatively unclear (McCambridge et al., 2011).

The juxtaposition of public acceptance, public health objectives, and still emerging long-term research is most prominent for cannabis. States are increasingly legalizing medical and recreational use, despite national restrictions as a Schedule 1

substance (Cerdá et al., 2012). Preclinical studies using mice models in randomized controlled trials and correlation studies in humans both suggest that cannabis use during sensitive periods influences brain development (Renard et al., 2014, 2016). However, recent research suggests that long-term cannabis use does not have permanent drawbacks for individual capability (Meier et al., 2018; Mokrysz & Freeman, 2018).

Even though the long-term impacts of cannabis use are unclear, public opinion of risk is rapidly decreasing. These changes in perceived risk are attributed to debates surrounding the legalization of cannabis and subsequent legalization of cannabis (Miech et al., 2017). Monitoring the Future, a nationwide epidemiological study that tracks trends in substance misuse, has uncovered several period effects since tracking began in the 1960s where perceived risk foreshadows increases in substance use (Keyes et al, 2011; Parker & Anthony, 2019 Schulenberg et al., 2018). Increased accessibility to and normalization of cannabis use associated with the rhetoric around legalization will likely increase cannabis use. With recent policy changes and uncertain long-term psychosocial impacts of substance misuse (Wittchen et al., 2009) it is urgent that the consequences of long-term use be investigated as many states move towards legalization.

Purpose of the Study

There is a massive body of research that surveils substance misuse in the U.S. There is also a large collection of research outlining short-term biological, educational, and social consequences of substance misuse. There is strong evidence for short-term negative consequences for substance misuse and evidence of long-term ill-health associated with regular substance misuse (McCambridge et al., 2011). However, there is

limited and inconsistent evidence of long-term psychosocial outcomes associated with periods of misuse (e.g. Fergusson & Boden, 2008; Patrick et al., 2016; Scholes-Balog et al., 2016; White et al., 2015). Epidemiological studies indicate that substance misuse is heaviest among the young; unfortunately, heavy use coincides with sensitive developmental stages preparatory to adulthood (Littlefield & Winograd, 2013). It is possible that periods of substance misuse that overlap with periods of critical development could have negative impacts on development. Yet, most individuals emerge from this period of development without notable long-term disadvantage, they simply mature out (Vergés et al., 2013). However, the claim that maturing out of substance misuse does not result in a disadvantage has not been explored extensively.

The present study investigated the changes in substance misuse between adolescent, emerging adulthood, and young adulthood and explored how these changes are associated with young adult outcomes. The research presented here considers differences between groups of individuals who have periods of substance misuse but matured out by young adulthood compared to those that either never engaged in misuse or those who never matured out of misuse as it pertains to adult psychosocial outcomes. The impact of maturing out of substance misuse on adult psychosocial development is not clear. Transitional life events that move individuals towards adult roles with more responsibility, like marriage, educational completion, or full-time employment, have been implicated as a contributor in maturing out (Dawson et al., 2006). Interestingly, individuals making this transition do not value these traditional marker indicators of adulthood as past generations valued them. Instead, contemporary values of adulthood

reflect intrinsic markers, like personal responsibility, autonomy in decision-making, and financial independence (Arnett, 1998, 2000a, 2004; Beckert et al., 2020). Together, these contemporary values have been termed, self-sufficiency or the ability to stand alone. These same intrinsic markers are implicated in maturing out of substance misuse, individuals no longer find substance misuse to be aligned with their view of adulthood (Littlefield & Winograd, 2013). Self-sufficiency is valued by individuals making the transition to adulthood, yet there is no current research on the impact of maturing out on these intrinsic markers of adulthood.

This work also extended current research by investigating polysubstance use, the use of more than one substance during a time period (Conway et al., 2013). Although polysubstance use best reflects use patterns in the U.S., it is often overlooked in research in favor of parsimony (Anthony et al., 2016). Research that considers polysubstance use better reflects the human experience associated with substances and constructively adds to our understanding of the impact of substance misuse. The current research uncovered how individuals move between substance misuse patterns as they transition into adulthood.

The present study also contributed to the pressing dialog surrounding the legalization of cannabis. Despite the amount of research produced surrounding the impact of cannabis on long-term health and psychosocial outcomes, there are still substantial holes in our understanding. While some research finds negative long-term impacts (Batalla et al., 2013; Fergusson & Boden, 2008; Hall & Degenhardt, 2009) other research find neutral impacts (Jager et al., 2006; Meier et al., 2013). To this point, research is

underpowered in its ability to guide legalization policy (Meier et al., 2018; Mokrysz & Freeman, 2018; Volkow, Baler, Compton, & Weiss, 2014). The current research extended a piece of what we know about regular cannabis use by comparing non-misusers, matured-out misusers, current misusers, and current cannabis users. This extension augments our understanding of the long-term psychosocial impacts of regular cannabis use.

Overview of Theoretical Framework

The research presented here uses a theoretical lens of life course theory (Elder, 1975), psychoanalytics (Erikson, 1982), and the theory of emerging adulthood (Arnett, 2000). It is important that substance misuse research prioritizes projects that span developmental stages because, from a life course perspective, development is progressive and additive (Elder, 1998). Meaning, earlier development influences (but does not dictate) later development. Data demonstrates that typical initiation occurs during adolescence (13 to 17 years of age), increases and diversifies through emerging adulthood (18 to 25 years of age), and declines in young adulthood (26 to 32 years of age). The setting and context for substance misuse is different within each of these developmental stages, and at the individual level illustrates the changing topography of substance misuse across time. In the context of adolescence as a preparatory stage for emerging adulthood, teens, while still regularly supervised by parents and the educational system, increase in independence. Peer influence gains salience and teens increasingly explore their options outside of their home environment (Curtis, 2015). For most, this exploration includes an initiation into substance use, and for some, an initiation into

substance misuse (Guttmannova et al., 2012). Similarly, emerging adulthood, the time of peak substance misuse, is a preparatory stage for young adulthood. The theory of emerging adulthood postulates a new developmental stage that exists between adolescence and emerging adulthood. Emerging adulthood is thought to be experienced in most westernized nations because of expanded time for exploration and education between adolescence and adulthood. It is a time of exploration, instability, possibilities, and independence (Arnett, 1998, 2000a). Development during emerging adulthood culminates with individuals settling into careers, families, and ideologies; in other words, emerging adulthood culminates with individuals settling into adulthood.

A major tenet of life course theory is that life is lived on trajectories built around routines and response patterns (Elder, 1975). Within a trajectory are transitions that may, or may not, result in new routines and patterns that change an individual's trajectory, these changes are called turning points. The time spanning adolescence to young adulthood is full of transition and opportunities for turning points. The way individuals maneuver through these transitions can result in increased or decreased adult wellbeing.

Historically, individuals were thought to arrive at adulthood following event-based turning points; marriage, steady employment, homeownership among other events, pivoted individuals onto an adult trajectory (Benson & Furstenberg, 2007). Some researchers no longer prioritize these events as the only, or even the most important, transition (and potential turning points) that bring individuals into adulthood (Arnett 1997, 1998, 2000a). Instead, most individuals moving towards adulthood experience transitions and turning points in a slower more diverse process (Arnett, 2004). Indeed,

emerging adults are aware of the slow and meandering path that brings them into adulthood and value the intrinsic capacities they build along the way (Arnett, 1998; Schulenberg et al., 2005). Instead of relying on event-based experiences, the turning point into adulthood is described by independence, often referred to in literature as self-sufficiency (Arnett, 1998: Nelson & Barry, 2005). Self-sufficiency is composed of autonomy in decision-making, personal responsibility, and financial independence (Arnett, 1998; 2000a; Nelson & Barry, 2005; Whittington & Peters, 1996). It is not currently clear how trajectories that include substance misuse influences how individuals can achieve self-sufficiency. To the extent that substance misuse can influence development, it is possible that periods of substance misuse between adolescence and young adulthood can influence how individuals settle into adult self-sufficiency.

To this end, this project investigated the impact of substance misuse on the psychosocial adult outcome of self-sufficiency. It considered substance misuse across adolescent, emerging adult, and young adult development to fill gaps in our understanding regarding how individual (1) change in use patterns across develop mental periods and (2) how change is associated with developmental outcomes in adulthood. Furthermore, this research isolated cannabis use patterns to better understand the psychosocial outcomes of cannabis use across developmental periods. This is a timely and pertinent issues as public opinion and policy regarding cannabis use are undergoing rapid transformations in a time when research is still underdeveloped on the long-term outcomes of regular use. Finally, predictors of change in substance misuse during these developmental periods were explored.

Results from this research inform science by highlighting individual pathways between substance behaviors across developmental periods and examine the impact of changing behaviors on young adult self-sufficiency. This project benefits public health by uncovering movement between substance misuse behaviors at the individual level and exposes intervention points. The proposed research adds meaningfully to our understanding of the long-term impacts of substance misuse behaviors on an important developmental milestone of adulthood, self-sufficiency.

Research Questions

The purpose of the study was to investigate changes in substance misuse between adolescence, emerging adulthood, and young adulthood and identify how these changes are associated with young adult outcomes of self-sufficiency. Using a longitudinal mixture model, heterogeneous patterns of polysubstance use were uncovered and transitions in polysubstance use patterns were explored. The frequency and meaning of the patterns add insight into how individuals use substances across these developmental periods and quantifies the amount and types of change that are most prevalent.

Extending on the findings from the longitudinal mixture model, this study reduced the multitude of individual pattern changes to explore the impact of terminal misuse condition, stable nonmisuse, matured-out, or continuing substance misuse, on young adult indicators of self-sufficiency. This simplified design provided insights into the relationship between individuals who experienced a turning point of maturing-out and important indicators of young adult psychosocial well-being.

This design also permitted the comparison of terminal misuse conditions on key developmental outcomes of young adulthood, contrasting the association with self-sufficiency between stable nonmisuse, continued misuse, and matured-out. Finally, continuing cannabis users were isolated from continuing illicit misusers. Continuing cannabis users were explored separately from continuing illicit misusers. The overarching research questions were as follows.

1. To what extent do individuals change substance misuse patterns across adolescent, emerging adult and young adult development?

2. Does experiencing the turning point of maturing out influence adult self-sufficiency compared to individuals who did not experience this turning point (stable non-misusers and continuing misusers)?

3. When continuing cannabis is considered as a unique pattern, what differences are seen between matured out, stable non-misusers, continuing illicit misusers, and continuing cannabis users in regard to indicators of self-sufficiency?

4. What is different between individuals who experience a maturing out turning point and those who do not?

The following chapters describe the study in detail. Chapter 2 discusses important lessons learned from substance misuse research. It covers the theoretical and practical necessity of continued research between initiation, escalation, and cessation that occurs between adolescence and young adulthood. It explores the changing political landscape of substance misuse, especially relating to cannabis. Chapter 3 explains the methodological and analytical strategies employed to answer the proposed questions using Add Health data. Results from analyses are explored in Chapter 4. Chapter 5 articulates the implications for research and practice emerging from the findings. Several appendices are included for technical specificity.

CHAPTER 2

REVIEW OF LITERATURE

This chapter identifies the theoretical perspectives that will be used to guide this research and will review literature relevant to the proposed research questions. First, the theoretical lens will be presented, with an emphasis on bridging adolescent, emerging adult, and young adult developmental periods. Then, trends and transitions in substance misuse will be considered. Next, this paper will explore cannabis history and policy in the U.S. Finally, the research designed used to estimate the association between patterns of risky substance misuse and adult self-sufficiency outcomes will be discussed.

Theoretical Framework

This dissertation frames the study of substance misuse, maturing out of misuse, and psychosocial outcomes in young adulthood in the context of life course theory (Elder, 1975). This frame of thought, first proposed in the domain of health sciences in the 1960s, expanded the view of health from a state-based marker of wellbeing to encompass dynamic health pathways across time (Burton-Jeangros et al., 2015). It considers how time, context, process, and meaning of human events converge on human development (Bengtson & All, 1993). In addition to using life course theory, the theories of psychosocial development (Erikson, 1950, 1959) and emerging adulthood (Arnett, 1998, 2000a) are used as anchors for the targeted developmental periods considered in this research. Although both the theory of psychosocial development and emerging adulthood were built outside the frame of life course theory, life course theory is interdisciplinary.

As such, it often incorporates conceptual themes that are found in stage or domain-specific theory and research, bridging the gap with principles of life course theory (Johnson, Crosnoe, & Elder, 2011). The following sections will outline tenets of life course, psychosocial, and emerging adult theories. It will connect substance misuse and theory to build the theoretical foundation upon which this dissertation is built.

Life Course Theory

A certainty of life is change. Life course theory describes how individuals develop in a changing world. Elder (1998), a founding leader in life course theory, stated that "changing lives alter developmental trajectories" (p. 1). The inevitable vicissitudes of life interact with our personal attributes and the environment to direct our developmental pathway.

Life course theory asserts that development is lifelong and that no stage can be understood in isolation (Dragastin & Elder, 1975; Johnson et al., 2011). It utilizes the terminology of trajectories, transitions, and turning points to describe the stability and change across the life course. Trajectories are pathways of long-term patterns of behavior. Within a trajectory, there are embedded transitions, life events that are time-limited (Elder, 1985, pp. 31-32). Elder described that "transitions are always embedded in trajectories that give them distinctive form and meaning" (Elder, 1985, p. 32). Transitions are points in time where individuals undergo changes in status (e.g., starting or leaving school, entering or leaving a job). Changes in status, whether favorable or unfavorable, produce stress. Coping with transitions necessitates adaptation. Individuals must build new routines and response patterns in the face of stress produced by transitions.

Transitions do not necessitate a change in trajectory. In many cases, the stress of a transition results in adaptation so individuals can maintain their current trajectory. Some transitions do terminate with a trajectory change, individuals adopt new routines and responses altering their trajectory towards the future. Transitions that alter trajectory in the long-term are called turning points. On one hand, turning points can result in trajectories of wellbeing; on the other hand, the stress of a transition can produce new routines and response patterns that do not favor wellbeing. Turning points can be abrupt, or they can be part of a process over time (Pickles & Rutter, 1991, p. 134). They can be positive (e.g., cohesive marriage, meaningful work) or they can be negative (e.g., substance dependence, job instability). Turning points, simply put, reflect a change in long-term patterns of behavior.

Consider for a moment what is known about general substance misuse. The timing of initiation, escalation, and diversification is nestled within highly transient developmental periods. Substance misuse during times of transition can become turning points that alter developmental trajectories. Substance misuse can become a part of new routines and response patterns to stress and can interact with the resources available to individuals as they progress through life. However, epidemiological trends show a normative maturing-out of substance misuse with age. Maturing out reflects a turning point, where new routines and response patterns replace old patterns, revising the trajectory of individuals. It is likely that many individuals experience trajectory changes involving substance misuse during their lifetime. Indeed, estimates from National Survey on Drug Use and Health (NSDUH) reported 8.4% of adults experienced a period of

substance dependence on in the past year alone, that estimate reflects over 20 million individuals (Substance Abuse and Mental Health Services Administration [SAMHSA], 2019). Yet, substance misuse is not often viewed through the lens of a life course theory, which limits the organizational framework by which we can research and discuss substance misuse (Hser et al., 2007). This project considered the timing, ordering, and subsequent consequences associated with substance misuse patterns during a highly transient period of human development in westernized cultures on young adult psychosocial milestones of self-sufficiency.

Transition into Adulthood

Adulthood is important to society. Adults have been described as mature individuals who can "on the one hand, realize aspirations and satisfy needs, and, on the other hand, change and cope with the environment" (Young, 1998, p. 1). This definition eloquently describes the ability of adults to be self-sufficient in meeting goals, providing for their needs, and handling the inevitable changes in the environment.

From a programmatic view, adults are employed, stable, safe, and healthy; they are involved in civic duties, maintain healthy relationships, and/or are effective parents (Bonnie, Stroud, & Breiner, 2015), indeed, adults are the functional unit of society. Yet, for decades the complexity of adulthood was reduced into simple transitional events that reflected the entry into adulthood.

Fifty years ago, the consensus for measuring when individuals reached adulthood was easy. Turning points of adulthood were milestone-based; completing education, establishing a career, entering into marriage and parenthood all marked adulthood (Hogan

& Astone, 1986; Winsborough, 1978). Given that these events could be measured with a single date, they were easy to quantify and perceive. Furthermore, in the 20th century, there was more uniformity in achieving these milestones, and strongly held societal beliefs about "correct" timing and order (Greene et al., 1992Plath & Ikeda, 1976).

Historically, milestone-based transitions were experienced earlier than they are in contemporary society, allowing for earlier entry into adult status. For example, the median number of years spent in pursuit of education in 1970 was 12.2 years (Office of Educational Research and Improvement, n.d.), in 2018 the median number of years increased to 13.7 years (U.S. Census Bureau, 2019). Age of first marriage as also increased dramatically, in 1970 age of first marriage for women was 20.6 years of age, in 2018 the average age jumped to 27.9 (U.S. Census Bureau, 2019).

Delayed transitions add barriers to reaching adult status. Additionally, there is greater variety in timing and order of historically accepted milestones than has existed in human history (Bonnie et al., 2015; Cohen, Kasen, et al., 2003; Greene et al., 1992). Delays in achieving milestones, along with greater variability in order of achieving milestones, has led some researchers to suggest that using milestones is antiquated and no longer appropriate (Arnett, 1998, 2000a; Kins & Beyers, 2010). Instead, modern views of the transition to adulthood are more abstract.

"Consider what is implied by the use of the phrase "the transition to adulthood." It implies the existence of a social idea of what it means to be an adult. That is, it implies that there is a commonly held view concerning the criteria that constitute adult status. Thus, adult status is not merely biological, but is a socially constructed, formed from the

criteria the members of a culture deem to be most important in signifying adult status." (Arnet, 1997, p. 4).

Until the late 1990s, little attention was given to the perceived experience of transitioning to adulthood. Although it was recognized that cultural criteria define what it means to be an adult, there was no record of how individuals perceived this change to occur. In a 1997 study, participants aged 18 to 28 were asked to indicate whether they thought an item must be achieved before a person can be considered an adult. Among the list of 40 items were milestone-based, and historically relevant items like marriage, parenthood, entry into a career, etc. The survey also included indicators that reflected cognitive, emotional, behavioral, biological, legal, and responsibility items. Interestingly, few historically relevant indicators were endorsed as being important to adult status. "Notably, the criteria most often employed in sociological studies—finish education, being full-time employment, marriage, and parenthood—were rejected by a large majority" (Arnett, 1997). Among the most widely endorsed indicators were autonomy in thinking and decision-making, personal responsibility, and financial stability. This has been replicated in other populations within the U.S. and studies have produced similar perceived indicators of adulthood by those experiencing the transition (Arnett, 1998; Beckert et al., 2020; Nelson & Barry, 2005). Together, these indicators have been described as the ability to "stand alone" or to be self-sufficient (Arnett, 2000a). Standing alone reflects an ability to take responsibility for actions and the consequence that follow, act autonomously, and be financially independent (Arnett, 2000a; Nelson & Barry, 2005; Whittington & Peters, 1996). Indeed, the results from studies investigating the perceived

experience of transitioning to adulthood better aligns research with the intricacies of being an adult. Self-sufficiency is better aligned with the ability of adults to "realize aspirations and satisfy needs, and…change and cope with the environment" (Young, 1998, p. 1).

Adult Developmental Timing

Early in the development of life course research, there was a focus on building models and definitions of successful development (Buchmann, 1989; Elder et al., 2003). In general, and despite the search for universal conditions of successful development, finding return great heterogeneity, especially during adulthood (Eliason et al., 2015; Wood et al., 2018). Instead of defining a prescriptive path, the search for commonalities in adult development has led to ideas of on-time and off-time development, collectively referred to as timing or age-grade development (Hogan & Atone, 1986).

One who is on time will accomplish milestones at developmentally appropriate times. For example, the emerging adult who attends college; this event is normative for individuals in this developmental stage. One who is off time experiences significant events outside of the normative timeframe. For example, the teenager who experiences the death of a parent; this event, while inevitable, is not expected until middle or late adulthood.

Notions of timing also incorporates the idea of order of events. "Correct" order reflects individuals who follow social norms for patterns of events (e.g., dating before marriage—at least for westernized cultures). Disordered timing reflects individuals who accomplish milestones out-of-order (e.g., moving out on your own before graduating

from high school). The timing of events sets into motion a sequence of cumulating advantages and disadvantages (Elder, 1998). On time and correctly ordered life events are accompanied by options, choices, and resources that may not exist during other developmental windows (Hser et al., 2007). There are potential lost or gained options, choices, and resources associated with different trajectories between adolescence and young adult development. These opportunities are often not easily recaptured once the appropriate time has passed.

Timing may be an important component of the impact of substance misuse on development. Given the relative consistency of substance misuse trends across development (i.e., initiation during adolescence, peak during emerging adulthood, and decline during young adulthood) substance misuse is normative or on-time. Some researchers suggest that experimentation with and escalation of substances during this developmental period is normative and prosocial (Parker et al., 2002; Shedler & Block, 1990). A study of 234 monozygotic male twins (117 twin pairs), where one twin used cannabis heavily during adolescence and emerging adulthood and the other did not use, found no significant differences in socio-demographic characteristics 20-years after cannabis use stopped (Eisen et al., 2002).

Socio-demographic characteristics measured in this study included current substance misuse, past 5-year physical and mental health service utilization, and health-related quality of life. This study suggests that heavy cannabis use during adolescence and emerging adulthood followed by a turning point away from cannabis use does not have long-lasting adverse sociodemographic outcomes (Eisen et al., 2002). Theoretically,

if individuals remain within the appropriate order and timing, then substance misuse could be considered a developmentally isolated risk. On the other hand, substance misuse can cause individuals to miss out on time-sensitive resources that are difficult to obtain off-time. Periods of substance misuse can interfere with educational pursuits and employment opportunities. Years can be lost to unproductivity, resulting in poorer outcomes in young adulthood and beyond. However, these hypotheses are not well investigated. Substantial concerns still exist about the long-term psychosocial impacts of substance misuse (Chassin et al., 2002; Oesterle, Hill, Hawkins, & Abbot, 2008).

Continuity and Discontinuity in Trajectories

A main tenant of life course theory emphasizes continuity and discontinuity in developmental trajectories. Behavioral research often finds that past behaviors are good predictors of future behaviors (Bentler & Speckart, 1981; Ouellette & Wood, 1998). This emphasizes continuity in development. As development unfolds, there is an accumulation of prior life advantages and risks that pave a path to the future. However, earlier development does not dictate future development (Elder, 1998; Johnson et al., 2011). The vicissitudes of life offer ample turning points, transitions to change developmental trajectory by breaking old routines and habits and replacing them with new routines and habits. Turning points can positively or negatively alter behavior. A turning point can provide an opportunity to deflect earlier behavioral trajectories and send individuals on divergent paths. This may be especially true in the case of substance misuse.

Individuals typically go from a state of nonuse to use during adolescence or emerging adulthood. During emerging adulthood, there is a peak in misuse and an

acceleration in frequency and intensity of misuse for many individuals. Then, substance misuse is mostly terminated by young adulthood. Longitudinal findings from the Monitoring the Future epidemical study found that the prevalence of alcohol misuse grew from 3.6% at age 14 to 32.5% by age 21. As individuals approached their thirties the number dropped to 25% (Johnston et al., 2019). A study investigating the cumulative probability of developing substance dependence for alcohol, cannabis, or cocaine identified similar trends towards reduced use with age. While a proportion of individuals transition to substance dependence after the 3-year period covered in the study (26.6% of alcohol misusers, 9.4% of cannabis misusers, and 15.6% of cocaine misusers transition to dependence), the majority tended towards less use (Flórez-Salamanca et al., 2013). Research investigating the natural course of cannabis misuse between adolescence to young adulthood found a similar trend. Between the ages of 16 and 30, approximately 19.1% of cannabis users became dependent; however, by age 30, about 81% of dependent users had matured out of use (Farmer et al., 2015). Evidence of discontinuity in substance misuse is replicated in research and supported by epidemiological tracking (Schulenberg et al., 2019).

Despite substantial evidence of discontinuity in substance misuse, there are occasions in research where discontinuity is discounted through theory or design. A major theoretical shortcoming is associated with the definition of adulthood. There is still considerable debate surrounding the theory of emerging adulthood (i.e., that the time between 18 and 25 years of age is a developmental period separate from adolescence or young adulthood with unique challenges and conflicts to resolve). Details of emerging

adulthood will be discussed in a future section. Briefly, emerging adulthood in theory and research characterizes individuals passing through this period as explorative, unstable, and self-focused (Arnett, 1998). The high prevalence of substance misuse is a symptom of exploration, instability, and self-focus.

As research has sought to describe the impact of substance misuse on adult psychosocial outcomes, terminal measurements often fall during emerging adulthood. These outcomes are less indicative of true adult traits; instead, they reflect a transient state. For example, a study investigating the association between adolescent substance misuse and young adult measures followed youth across 6 waves from age 11 to age 21. The terminal wave, at age 21, was considered young adulthood. There were no differences between earlier substance use patterns and measures of adulthood; employment, school completion, post-secondary education, and income (Sholes-Balog et al., 2016). However, the differences between groups are possibly biased by design. Consider the measurement of income. According to the U.S. Department of Labor, individuals between the ages of 20 and 24 are less likely to participate in the labor market, 67.8%, than those between the ages of 25 and 34, 81.6%. Of those engaged in the labor force, people between the ages of 20 and 24 earn an average of $572 per week; individuals aged 25 to 34 make $806 per week. Individuals in their early-20s less likely to have professional or managerial jobs than individuals in the late-20s and early-30s, 23.9% compared to 41.5% (U.S. Bureau of Labor Statistics, n.d.). These differences are in a large part attributed to age, advancement into higher paying, more professional careers require education, experience, and time.

Measures of secondary education are equally trivial when measured during emerging adulthood. There is great heterogeneity in educational paths after high school. In response to this heterogeneity, the U.S. government delays tracking education attainment until age 25 (U.S. Census Bureau, 2019). Similarly, secondary education institutions postpone graduation reporting to 6-year completion rates; despite that degrees are designed to take only 4 years (National Postsecondary Education Cooperative, 2009). This expanded time for reporting better reflects the human experience with education after high school (Denice, 2019). Attempting to decipher the difference between education outcomes by substance use classification at the age of 21 will not reflect a terminal attainment status. Failing to account for contemporary trends in adulthood obscures the association between substance misuse and young adult outcomes.

Another way discontinuity in substance misuse may be discounted in research stems from treating adolescence substance use as an indicator of substance pattern across time. Research from this perspective suggests that substance use behaviors are established early in development. This is evident in paradigms that emphasize initiation-time and initiation-experience in substance misuse research (Grant & Dawson, 1997; Jordan & Andersen, 2017; U.S. HHS, 2016). These studies have added to our collective knowledge by turning our attention to delaying initiation and restricting access to minors. In fact, delaying initiation and restricting access to minors are major objectives for demand reduction. However, trend tracking shows increasing initiation and escalating intensity from adolescence to emerging adulthood (Johnston et al., 2019). There are a wide range of transitions and turning points for substance misuse in the second and third

decade of life. Research that explores these transitions across development should be prioritized as it reflects the contemporary human experience with substance misuse.

Sensitive Development

Sensitive periods of development describe periods when skills or characteristics can most advantageously be acquired (American Psychological Association [APA], n.d.). In this sense, adolescence and emerging adulthood can be considered sensitive periods for physical and psycho-social development (Wood et al., 2018). Adolescence and emerging adulthood are important developmental periods for psycho-social development as they mark a period of increasing independence. With independence, individuals become co-developers in their own future. They adaptively respond to biological, social, cultural, and physical contexts (Learner & Overton, 2008). During adolescence, individuals forge a personal identity that, while still monitored by parents, is increasingly independent of parents (Curtis, 2015). The incremental change in independent thought and behavior primes individuals for emerging adulthood.

Emerging adulthood is characterized by exploration, instability, self-focus, and possibility (Arnett, 1997, 1998, 2004). In fact, this developmental period is considered a sensitive period to engage in these domains (Wood et al., 2018). Many during this developmental period will experiment with self-sufficiency, living independently, making independent decisions, engaging in committed relationships, etc. However, most of these experimentations in self-sufficiency are relatively short lived. Many emerging adults will return home after periods of living independently or change living arrangements regularly. Relationship initiated during emerging adulthood increase in their seriousness

but are often temporary. Independent decisions may lead to consequences that need to be sorted out with parents (Arnett, 2017; Smith et al., 2011, pp. 72-75).

How individuals navigate the developmental challenges inherent in adolescence and emerging adulthood will likely influence developmental trajectories of adulthood (Wood et al., 2018). As individuals approach their late 20s and early 30s, the gains made (to varying extents) cumulate in commitments to self, family, and community as the time of possibilities (emerging adulthood) comes to an end.

Interestingly, but not surprisingly, substance misuse also peaks during these developmentally sensitive years (Sussman & Arnett, 2014). Substance misuse may interfere with the exploration, instability, self-focus, and possibilities of emerging adulthood, and may limit the gains made during emerging adulthood towards the young adult milestone of self-sufficiency. However, the extent to which substance misuse influence young adult self-sufficiency is not clearly understood. Some research has shown that substance misuse during earlier developmental periods is associated with lower levels of competence in young adulthood compared with low or non-users (e.g., Ellickson, Tucker, & Klein, 2003; Fergusson & Boden, 2008; Patton et al, 2007; Wiesner & Windle, 2004). Other research has identified no long-term effects of early risky substance misuse on adult functioning (Meier et al., 2018; Mokrysz & Freeman, 2018; Oesterle et al., 2008; White et al., 2015). Further research finds differences between substance misuse type and adult development (Bogart et al., 2007; Patrick et al., 2016; Stein, Smith, Guy, & Bentler, 1993).

A comprehensive review investigating the consequences of adolescent alcohol

misuse on adult health and well-being similarly found inconclusive long-term effects (McCambridge et al., 2011). While there was a clear positive association between adolescent alcohol misuse and adult alcohol abuse and dependence, the association between alcohol misuse during adolescence and psychosocial adult outcomes was unclear. The authors conclude that lack of evidence between adolescent alcohol misuse and psychosocial outcomes was a product of the absence of evidence rather than strong evidence of no effect. Additional high quality, longitudinal research is necessary to understand the developmental relationships between patterns of substance on adult self-sufficiency. Given the sensitive nature of adolescence and emerging adulthood, it is possible that an extended period of substance misuse could directly interfere with becoming self-sufficient in young adulthood.

Lost years of experience or missed opportunities (e.g., education, employment) during younger ages because of early deviant behaviors or lifestyles (e.g., drug use, criminal activities) often cannot be easily recaptured or can be recaptured only at a high intervention cost. It appears that many options, choices, and resources are available only during specific development periods, with a disproportionate number presenting in the earlier years of life (Hser et al., 2007). Further research is warranted to gain an understanding of substance misuse during these developmentally sensitive periods.

Psychosocial Development Theory

The continuity of psychosocial development theory lends itself to life course theory. Psychosocial development, while theorized prior to life course theory, is similarly interested in the social forces that shape development (Elder, 1994). The theory of

psychosocial development has its roots in classical psychoanalytics. Psychoanalytics, developed by Sigmund Freud, theorizes that development is determined by instinctual drives rooted in the unconscious brain. The id (instinctual drives) and superego (the moral compass) are balanced by the ego (man as he is). The ego has the constant role of mediating between the urges from the id and the ideologies of the superego. Erik Erikson, considered to be the father of psychosocial developmental theory, was tutored under Sigmund and Anna Freud. Although Erikson accepted Freudian theories, he found ego psychology to be underdeveloped. As postulated by Freud, the ego was driven by desires (id), morals (superego), and early childhood experiences in the parent-child relationship. Instead, Erikson theorized that the ego was essential in the developmental progress of self. He recognized that psychoanalytics did not account for the influence of culture, personal experience, and maturation on development. Turning his attention to social development across the life span, Erikson postulated a theory that has found longstanding merit within academia as he focused on the developing ego.

At the core of the theory are developmentally restricted crises that must be resolved. The resolution of these crises influences later development. While the theory of psychosocial development defines eight developmental stages across the lifespan, only two will be discussed here—the stages of ego-identity verse role confusion and intimacy verse isolation. The main task during this time period is to develop a sense of self. A successful resolution of this stage produces an individual who has a sense of identity, an identity to which they can remain faithful, even in the face of problems and differing perspectives. The resolution of the conflict of ego-identity versus role-confusion results

in individuals who have developed fidelity to an ideology in love, work, and world view. This resolution is necessary for healthy adjustment in adulthood (Erikson, 1968).

> Fidelity, when fully matured, is the strength of disciplined devotion. It is gained in the involvement of youth in such experiences as real the essences of the era they are to join—as the beneficiaries of its traditions, as the practitioners and innovators of its technology, as renewers of its ethical strength, as rebels bent on the destruction of the outlived, and as deviants with the deviant commitments. (p. 19)

The stage of ego-identity verse role-confusion was originally postulated to occur between the ages of 12 and 18. Interestingly, but not surprisingly, the historical context surrounding the development of psychosocial theory aligned with cultural forces that shaped adolescence as we know it today. The Fair Labor Standards Act of 1938 prohibited full-time employment of anyone under the age of 16 and enacted a national minimum wage which made employing children economically unviable for employers. This act was an artifact of social changes originating in the late 19th century. A major motivation for this law stemmed from a desire to educate youth to improve their prospects for the future (Moehling, 1998a). As Erikson viewed the social changes of the time, he and other psychologists of the era, had front row seats to the emergence of a socially sanctioned period of adolescent development.

Given Erikson's focus on the developing ego across the lifespan, the crisis of identity verse role confusion in the period between childhood and adulthood required the development of the ego-identity from immaturity to maturity. The process of ego-identity developed is described as a "partially conscious and largely unconscious" (Erikson, 1959, p. 11) psychological and sociological undertaking. By exploring possibilities outside of their home context, youth test options for their adult life. Through exposure to diverse

experiences and opinions, individuals may begin to answer the questions, “Who am I? How do I fit into society?” During this phase individuals search for something to be true to.

> This search is easily misunderstood, and often it is only dimly perceived by the individual himself, because youth…must often test extremes before settling on a considered course. These extremes, particularly in times of ideological confusion and widespread marginality of identity, may include not only rebellious but also deviant, delinquent, and self-destructive tendencies. (Erikson, 1959, p. 3)

The stress experienced during adolescence, Erikson suggests, is a natural process as the ego-identity develops from immaturity to maturity that requires exposure to diverse experiences. With a disposition towards testing limits during this time of identity formation, it is understandable that substance misuse is a concern for the developmental stage. In fact, it has been argued that developing an appropriated relationship with alcohol (and cannabis as legalization status changes) is an important developmental task (Masten et al., 2008). The transition from underage drinking to adult alcohol consumption shows a tendency towards more responsible use; young adults consume fewer drinks on each occasion than adolescence or emerging adults (Masten et al., 2009). Yet, developmental specialists warn that substance misuse during developmentally sensitive periods like adolescence and emerging adulthood could have long-lasting impacts on development by diminishing the time and energy available for identity formation thus limiting potential gains in psychosocial adult functioning (Baumrind & Moselle, 1985; Sussman & Arnett, 2014).

The psychosocial developmental stage proposed to follow the ego-identity verse role confusion conflict is intimacy verse isolation. Erikson defined love as an honest

closeness that individuals can share. This is most often viewed as romantic pair bonding but can be extended to all close relationships. The main conflict of this stage of development is intimacy verse isolation. Essential to developing intimacy is the successful resolution of the identity verse role confusion conflict. After individuals develop a sense of self, they are prepared to share their identity with others. Outside of a healthy identity, intimacy is difficult to accomplish (Erikson, 1961). Erikson proposed that an individual in the stage of ego-identity verse role confusion are "unable to love in that binding manner which only two identities can offer each other; nor to care consistently enough" to form intimate relationships.

The proposed timing of this developmental stage is between the ages of 20 to 40. Since the inception of psychosocial theory, Erikson proposed a psychosocial moratorium as an extension of adolescence where individuals can explore their options in work, love, and worldview. This is a socially accepted delay in transitioning for individuals to successfully resolve the ego-identity verse role-confusion conflict before seeking intimate relationships. During the 1950s when this theory was first proposed, the psychosocial moratorium was short-lived, terminating by age 24 (Erikson, 1958), and reserved for only a small proportion of individuals, mostly college attending youth. Psychosocial moratorium, as proposed by Erikson, was more the exception than the rule for youth. However, much has changed since the 1950s adolescence-based ego-identity verse role confusion stage was theorized.

Contemporary society has seen a lengthening between adolescence and young adulthood. Many individuals select into (and others are pushed into) a moratorium

between adolescence and young adulthood. There have been major shifts in the education-to-work transition requiring many to postpone their identity formation until education is terminated and gainful work is obtained (Côté, 2006). There are more diverse paths to adulthood and less structured guidance. Some researchers suggest that this meandering towards adulthood be considered a moratorium, an extension of adolescent (Côté, 2006; Snarey et al., 1983). However, others suggest that this prolonged space between adolescence and young adulthood is a new stage of development that should be considered separately; this stage is called emerging adulthood (Arnett, 1997).

Functional Phases & Cultural Ages

Before emerging adulthood can be addressed, it is important to highlight the controversy associated with adding a new developmental age. At the heart of the debate surrounding the addition of a new developmental phase is the question about how it influences the theory of psychosocial development. Both adolescence and emerging adulthood have been theorized to be the epicenter of identity formation. From the inception of the theory, adolescence was suggested as the time designated for identity formation. However, contemporary trends suggest that identity formation is delayed until the late 20s (Côté, 2006). To temper the debate, theorists have turned to definitions outline by Snarey et al. (1983). In a clarifying move, the authors suggested a unified language between functional phases and cultural ages. A functional phase reflects a quantitative and qualitative shift necessary for subsequent development. The progress of maturation is dependent on development that occurs within a functional developmental phase.

On the other hand, cultural ages are critically linked by age. Cultural ages are used to categorize individuals. Within a cultural age there are normative quantitative changes that are expected to occur; individuals gain mastery, rights, and responsibilities as they pass through each cultural age. Aligning language with the unified definitions suggested by Snarey et al. (1983) adolescence and emerging adulthood are cultural ages; the psychosocial developmental crisis of ego-identify verse role confusion is a functional phase.

The resolution of psychosocial conflicts is not strictly limited to cultural age. In fact, Côté (2006), explored identity resolution between individuals in late adolescence (17 to 20), emerging adulthood (20 to 23), and young adulthood (26 to 29). The study considered identity formation, defined as feeling like an adult and developing fidelity in niche, lifestyle, and community. Identity formation increased with age, with late adolescents having the lowest levels of identity formation and young adults having the highest. The gains made between emerging adulthood and young adulthood were substantially larger than the gains made between late adolescence and emerging adulthood. Interestingly, this research also revealed lower identity development than expected by young adulthood. Only 1 in 3 participants completely resolved their identity stage by their late 20s, suggesting there is still room for growth in identity formation past young adulthood. These finding echo speculations made by Erikson, that “the delay of adulthood can be prolonged and intensified to a forceful and fateful degree” (Erikson, 1961, p.12).

Theory of Emerging Adulthood

Just as psychosocial theory emerged during a time of changing historical trends (i.e., the socially sanctioned [and federally protected] period of adolescence), the theory of emerging adulthood is a product of contemporary trends. The latter half of the 20th century experienced substantial cultural changes that alleviated stringent expectations for the transition to adulthood. The women's rights movement broke down cultural barriers that constrained women for centuries to the role of wife and mother. Educational and vocational opportunities that were once withheld from women became viable possibilities. The sexual revolution and accessibility of birth control transformed sexual norms, allowing individuals to have regular sexual relationships outside of marriage. The higher education act, created public universities, paving the way for more citizens to receive advanced education and training post-high school. These transformative movements gave birth to a period of exploration and innumerable opportunities for individuals to explore. With so many options and so much freedom, a new cultural age was born (Côté, 2006).

Emerging adulthood, first theorized by Arnett (2000a), conceptualized the development of contemporary youth in industrialized societies, like the U.S. It describes a unique period of development that is distinct from adolescence that precedes it and young adulthood that follows it. For most, this developmental period is experienced between the ages of 18 and 25. At the age of 18, individuals achieve relative autonomy from the supervision of guardians. They experience a shift in social roles and normative behavioral expectations. During this period, individuals are liberated from the

dependency and monitoring that is characteristic of childhood and adolescence. They are also free from the social roles and normative behavior expectations of adulthood. This period is distinct in five dimensions from other developmental periods: it is the age of (1) identity formation, (2) feeling in between, (3) possibilities, (4) self-focus, and (5) instability. During this socially sanctioned period, individuals can explore, attend to their individuality, and eventually reach a state of self-sufficiency.

Emerging Adulthood and Substance Misuse

Epidemiological studies tracking substance use, consistently place emerging adulthood as the peak of substance misuse. Careful consideration of the dimensions of emerging adulthood adds insights into why this peak coincides with emerging adulthood. The dimension of possibility is characterized by optimism. In response to a survey question that asked, "I am very sure that someday I will get to where I want to be in life," 96% of emerging adults agreed. Indeed, emerging adults "envision a well-paying, satisfying job, a loving, lifelong marriage, and happy children who are above average" (Arnett, 2004, p. 16). Emerging adults may feel invulnerable to negative life consequences. Many operate under the notion that what happens in emerging adulthood, stays in young adulthood (Smith, et al., 2011, p. 120). As part of exploring the possibilities of life, risky behaviors are most tolerated and even encouraged during emerging adulthood (Sussman & Arnett, 2014). Combining the promotion of risky behaviors with a lens of intense optimism can contribute to substance misuse. Additionally, substance misuse becomes a more pragmatic and attractive possibility during emerging adulthood than during any other developmental period. There is less

supervision, greater accessibility, and an attractiveness that pulls emerging adults towards riskier use patterns (Sussman et al., 2011).

The dimension of self-focus is also facilitative of substance misuse. Self-focus refers to the ability to make decisions and explore opportunities autonomously (Arnett, 2000a). The term is not intended to be pejorative, in fact, self-focus is normative and even necessary to prepare emerging adults for the future. In its most benevolent form, self-focus encourages youth to invest in themselves for the future, to spend time exploring options, and to test paths that are aligned with their vision of the future. However, self-focus is not always interpreted and applied in this manner. Instead, self-focus can be realized through self-interest or even hedonism; selfishness masquerading as self-focus (Sussman & Arnett, 2014). With increased autonomy and decreased social control, emerging adults often experiment with substances. Free from supervision and responsibility to others, substance misuse increases during emerging adulthood (Kypri, McCarthy, Coe, & Brown, 2004).

Instability is characteristic of emerging adulthood; housing, relationships, and jobs change regularly during this period. Emerging adults perceive their life to be unpredictable (Arnett, 1997; Reifman et al., 2007). In the setting of quick turnover in living, relationships, and jobs, individuals may take an experimental stance towards life (Sussman & Arnett, 2014). Many emerging adults will make decisions under the assumption that the behavior and its consequence will be temporary and without lasting consequences (Smith et al., 2011). This perspective on decisions can be facilitative of substance misuse (Sussman & Arnett, 2014).

The characteristics of emerging adulthood, along with cultural permissiveness, creates a space for potential substance misuse during emerging adulthood. These cultural and developmental factors may help explain why substance misuse peaks during emerging adulthood. As individuals transition towards self-sufficiency, this socially sanctioned time ends. Although the alignment of emerging adulthood and the peak in substance misuse can be understood theoretically, the consequences are not well understood. “Well-invested efforts [during emerging adulthood] can compound to launch people into satisfying and successful lives; however, loosely structured moratorium can have an opposite effect” (Côté, 2002). Given that substance misuse is prevalent and culturally permissible during emerging adulthood, it is possible that maturing out of substance use is normative and does not negatively impact young adult self-sufficiency. However, to the extent that substance misuse can interfere with development, even normative and socially sanctioned substance misuse can influence young adult outcomes.

Transitions in Substance Misuse Across the Life Span

Trends in substance misuse have been closely monitored for decades (Johnston et al., 2019). Trends clearly show that normative initiation begins in adolescence, peaks during emerging adulthood, and declines as individuals move towards young adulthood. While trends have held relatively consistent, with some gains in lowering substance misuse for adolescence in recent years, the peak and decline have seen little change (Johnston et al., 2019). Despite the value placed on general population trend monitoring, research has consistently shown that there is not a single, uniform trend; instead, there are

multiple patterns of substance misuse and progression (Merrin & Leadbeater, 2018).

Common patterns of substance misuse are identified through mixture modeling. Mixture modeling is a powerful, person-centered technique that exposes common response patterns across multiple observed variables. Research using mixture modeling to study substance misuse consistently finds that this behavior is better reflected by multiple common patterns of substance misuse than a single general pattern. In fact, a recent review of latent class analyses during adolescence found three-class to four-class solutions were most common (Tomczyk, Isensee, & Hanewinkel, 2016). And, among the studies examined, the exposed latent classes reflected similar behavior patterns across studies. Specifically, most latent class analyses included a no-to-low use pattern, an alcohol use pattern, and a polysubstance misuse pattern. Consistent findings regarding multiple common patterns of use suggest that for the general population substance patterns are not uniform among individuals during adolescence. Similarly, heterogeneity of common patterns of use are evident in substance misuse behaviors in emerging adulthood (Cleveland, Mallett, White, Turrisi, & Favero, 2013; Evans-Polce, Lanza, Maggs, 2016; Tzilos et al., 2016).

Expanding on the heterogeneity evident in risky substance misuse, growth mixture models have been utilized to give shape to behavioral trajectories across time by latent classification (Jung & Wickrama, 2008; B. Muthén & Muthén, 2000). Several studies have shown differential growth patterns based on initial class membership. Differential growth has been shown for polysubstance misusers (Tucker et al., 2005), risky alcohol users (Chassin, Pitts, & Prost, 2002; Maggs & Schulenberg, 2004), and

cannabis users (Flory et al., 2004; White et al., 2015). Early initiation and steady-increasing users have been associated with deleterious outcomes in young adulthood (Grant & Dawson, 1997; Patrick et al., 2017; Perkonigg et al., 2008).

Findings from growth mixture models provide evidence for the importance of the initial rate of use on future trajectories and outcomes. This supports other research that has highlighted the importance of intervening during early adolescence to delay the age of initiation (Grant & Dawson, 1997; Perkonigg et al., 2008). While respecting the need for prevention efforts that delay and protect teens (and, hopefully extending throughout development), it is important to recognize a weakness of growth mixture models. Specifically, that they restrict movement between classes to behaviors observed at the baseline (Curran, Obeidat, & Losardo, 2010). This assumption is likely unreasonable across adolescent, emerging adult, and young adult developmental stages because of the instability associated with these stages.

Instability is characteristic of emerging adulthood. Instability is observed in relationships, employment, education, and residency (Arnett, 1997, 1998, 2004). One study on holistic well-being between adolescence and young adulthood considered a latent transition analysis to identify movement between overall health behaviors. Results showed that few individuals engaged in consistently salubrious lifestyles between adolescence and young adulthood (Lawrence et al., 2017). It is probable that substance misuse behaviors are similarly unstable as they span developmental periods of life. Yet, individual movement between substance misuse patterns has not been studied across adolescent, emerging adult, and young adult development. Studies that have considered

transitions in behaviors show high stability, in other words, high likelihood to maintain earlier patterns of use (Choi et al., 2018; Lanza et al., 2010).

A mixture model that permits change in substance use pattern across time are longitudinal mixture models (LMM). These models permit individuals to shift in their pattern of use and can quantify transitions and stabilities across time. Current research on substance misuse using LMM suggest high levels of stability. When transitions are considered on the short-term, Lanza et al. (2010) found high stability in college student substance use patterns. Highest stability was seen within polysubstance use of cannabis and alcohol across a 2-week period. Chung et al. (2013) considered transitions in substance misuse between high school and emerging adulthood (wave 1 ages 13 to 17, wave 5 ages 18 to 22).

High stability in substance misuse patterns were observed for these participants. Mistry et al. (2015) followed 10th graders for 5-years with three data collection waves. Greater transition was observed during earlier waves, with more movement away from non-use and towards different use patterns. More stability was seen in substance use patterns between the second and third wave of data collection. Merrin et al. (2018) followed a group of participants across 10 years. At wave 1 participants were aged 12 to 18, at the final collection period, wave 6, participants were between the ages of 22 and 28. This study uncovered greater stability in use patterns than movement (58% to 94%) across all waves. Across the duration of the study there was a greater likelihood to transition towards more varied substance use patterns and fewer transitions towards patterns of less use. Taken together, these studies suggest there is strong stability across

time in substance misuse patterns.

Some research suggests that the natural course of cannabis use shows substantial stability, even as individuals mature into young adulthood. Perkonigg et al. (2008) investigated the natural course of cannabis use in a community sample across a decade. They found that among those with regular baseline cannabis use, those aged14 to 24 were unlikely to decrease cannabis use 10 years later. A major conclusion from the research was that cannabis use, when initiated early and used with regularity was likely to remain stable into emerging and young adulthood. Authors suggested that early targeted prevention measures should be employed to delay first use and reduce the number of experiences with cannabis. Among the general population, however, transitions in cannabis use across the transition to adulthood are evident. Past 30-day cannabis use oscillated between 14.6% in adolescence to 26.0% in emerging adulthood, and, then to 18% by young adulthood (Johnston et al., 2019; Miech et al., 2020;).

Substance use patterns for illicit drugs like amphetamines, cocaine, and opioids similarly depict patterns of stability and change. In a meta-analysis of remission rates from various illicit substances, Calabria et al. (2010) summarized that remission rates for dependent users ranged between 16% and 66%, with an average remission rate of 36.5% for chronically dependent users. In Winick's (1962) pioneering report on maturing out of narcotics use, he theorized that a substantial portion of narcotic users mature out of use without intervention by young adulthood. More recently, the U.S. Surgeon General's 2016 report projected that 25 million Americans were living in recovery from some prior substance dependence (U.S. DHHS, 2016).

The juxtaposition of literature suggesting high stability among substance use patterns and literature tracking trends suggesting variability highlights a hole in our current knowledge about the natural course of substance misuse in the general population across the transition to adulthood. This lack of knowledge has real-world policy implications. Where great stability exists, early prevention of substance misuse could be a salient means to reducing misuse. Where more variability exists, a diverse plan to prevent misuse should be followed. Furthermore, gaps in the long-term psychosocial consequences of substance misuse place us at a disadvantage. Where individuals seamlessly mature-out of misuse with no long-term self-sufficiency consequences, the focus should be on mitigating the short-term consequences of misuse. Where maturing-out of use places young adults at a disadvantage, more robust and long-term solutions should be explored.

Importance of Maturing Out

Lifetime illicit substance misuse is relatively high in the general population, with 81% of adults reporting some illicit substance misuse during their lifetime (Schulenberg et al., 2019). Past month illicit use is 32.67%. While these proportions do not reflect patterns of use and likely overestimates problematic use, it highlights the relative occurrence of substance misuse in the general population.

Despite the large number of individuals who engage in substance misuse during adolescence and emerging adulthood, most mature out of substance misuse without notable obstacles around the start of young adulthood (Klingemann & Sobell, 2001; Winick, 1962). While it is good news that most youth who experiment with substance

misuse will not grapple with lifelong addictions, substance misuse during a sensitive period of development may have social consequences that are less obvious to discern (Arnett & Tanner, 2006; Smith et al., 2011). Arnett and Tanner explains one of the fallacies of emerging adulthood is compartmentalization, a belief that "what happens in emerging adulthood…stays in emerging adulthood. The experiences and influences can be hermetically sealed off for later life, many suppose, when emerging adulthood is over and real life begins" (p. 120). Many of the decisions made during emerging adulthood can have lasting impacts and alter life course trajectories (Côté, 2002).

The phenomenon of maturing out was first documented by Winick (1962). Working with opioid users, Winick noted a natural recovery from narcotic use with age, that is, a recovery from use that was not accompanied by medical or psychological supports. This phenomenon was termed maturing out of substance misuse. Maturing out has been replicated across different samples and substances (Hunt & Odoroff, 1962; Nurco et al., 1975; Sobell et al., 2000) and can be seen in general population epidemiological trends (Schulenberg et al., 2019).

While recognizing the adventitiousness of maturing out (i.e., that individuals naturally age-out of substance misuse), the phenomenon of maturing out can lead to dangerous conclusions. Evidence of maturation, in some cases, has led people to minimize the risks associated with experimental or prolonged substance misuse (Parker et al., 2002; Shedler & Block, 1990; Sussman & Arnett, 2009). However, it is important to recognize that substance misuse is often incongruent with healthy developmental. Substance misuse can impact educational attainment (Ho & Krishna, 2016), career

opportunities (Dawson et al., 2006), world view (Shepperd et al., 2014), or social and romantic personal relationships (Willoughby, Hall, & Goff, 2015).

From a life course perspective, early development influences later development. To the extent that substance misuse can influence developmental trajectories, it is possible that effects of periods of substance misuse may not end with the risky behaviors themselves. Instead, consequences may span into adult development influencing psycho-social development that are less obvious to discern (Tanner & Arnett, 2016). Substance misuse choices may interfere with the process of becoming self-sufficient adults (i.e., being autonomous, responsible, and financially independent). Understanding the impact of patterns of substance misuse across the transition to adulthood is necessary as we seek to support development and perpetuation a stable society.

Cannabis and Changing Policy

The most used illicit substance is cannabis (Schulenberg et al., 2019). Cannabis is so widely accepted states across the nation are legalizing recreational use. Yet, the long-term impacts of cannabis are not thoroughly understood. Some research suggests long-term harm (Renard et al., 2014, 2016), while other research does not find evidence of long-term harm (Meier et al., 2018; Mokrysz & Freeman, 2018).

Even though the long-term impacts of cannabis use are unclear, public opinion of risk is rapidly decreasing. Research has found that decreases in perceived risk foreshadow increased use (Keyes et al, 2011; Parker & Anthony, 2018; Schulenberg et al., 2019). It is likely, then, that the U.S. should expected increase cannabis use across the

next several decades. It is urgent that more attention be given to investigate the impacts of cannabis as many states move towards legalization.

The following section contains a brief history of cannabis policy, a review of how cannabis affects the brain, general attitudes towards cannabis, and how policy may impact society as recreational cannabis becomes common place.

Cannabis Policy History: A Brief Review

Cannabis policy has undergone drastic changes over the past century. Until 1937, cannabis was legal in all 50 states and under federal law. The criminalization of cannabis temporally followed the end of alcohol prohibition in 1933. During the era of prohibition (1920 to 1933), the Department of Justice (DOJ) was tasked to enforce prohibition. Additionally, the standalone Federal Bureau of Narcotics (FBN) was established to support prohibition enforcement and enforce the control of opiates and cocaine. Following the termination of prohibition, resources within the DOJ and FBN remained available for monitoring narcotics and attention was turned to cannabis. In testimony provided to Congress as part of the proposed Marihuana Tax Act (MTA), the Commissioner of the FBN stated that "the major criminal in the U.S. is the drug addict; that of all the offenses committed against the laws of this country, the narcotic addict is the most frequent offender" (U.S. Congress and House Committee, 1937). In 1937, the MTA was passed by Congress which unofficially banned cannabis through obstructive policy. Within only a few years after passing the MTA, all 50 states made cannabis an illegal substance (Sacco, 2014).

Through the mid-20th century, the U.S. government continued to pass legislation

that increased controlled and further criminalized substance misuse. In the 1950s, mandatory prison sentences were established for drug offenses. In 1970, the Controlled Substance Act (CSA) placed the control of narcotics under federal jurisdiction as part of the DOJ (U.S. Drug Enforcement Administration, 1970). This reframing of drug policy leaned heavily on paradigms of criminology. Under the CSA substances were classified according to (a) perceived harm, (b) potential for abuse, and (c) potential for legitimate medical use. Cannabis was categorized as a schedule 1 substance with high perceived harm, high potential for abuse, and no legitimate medical use (Shulgin, 1988).

Concurrent with increased regulation of substances between the 1950s and 1970s, some circles within the government pushed for revisions of laws in favor of framing substance misuse as a public health problem. Suggestions included eliminating mandatory sentences, researching the benefits of rehabilitation, consulting the medical community in legislation matters, and dismantling the FBN (Papers of John F. Kennedy, 1963). The public health lens gained traction in Congress when they passed the Narcotic Addict Rehabilitation Act (Friedman, Horvat, & Levinson, 1982). This act used a public health framework by supporting rehabilitation for addicts in lieu of prosecution and sentencing. The emergent push for a public health lens in combatting the drug market was short-lived in when, in 1971, President Nixon declared war on drugs.

The war on drugs emphasized the role of law enforcement in reducing both the supply and demand for illegal substances. Supply reduction deals with the allocation resources to disrupt the production and distribution channels of illicit substances. Supply reduction effort encompasses domestic and international law enforcement, along with

interdiction. Historically, supply reduction efforts have received the most funding and attention in combatting the drug market (Anthony, 2005). The strategies for demand reduction have been less constant across time.

Originally, there was a strong belief that demand could be curbed through law enforcement; mandatory and harsh punishments were believed to deter participation in the drug market (Anthony, 2016). This perspective has shifted in recent years, returning to a public health lens, unfortunately, the funding associated with this view has not followed the paradigm change (Drug Policy Alliance, 2015). Demand reduction funding encompasses prevention, treatment, research, and policy efforts. Within the demand reduction budget, most of the funding is given to treatment through rehabilitation. Prevention, research, and policy efforts account for only a small portion of spending. This priority places the U.S. in a reactionary position, tackling problems we do not fully understand on the backend instead of seeking to understand and prevent substance abuse.

It will be necessary that adjustments to the U.S. drug control goals and policy be updated if cannabis transitions to a licit substance. In 2013 cannabis seizures made up 95% of the total amount of drug seized at the U.S. boarder and accounted for 30% of total drug related arrests in the U.S. (Sacco, 2014). This reflects both the availability and popularity of cannabis in the nation. Yet, over the past decade major changes in cannabis policy have made cannabis more available and more socially acceptable.

The modern era of cannabis debates was born out of two main movements. First, the realization that the war on drugs did not drastically curb crime and drug use. Between 1971, when the war on drugs began, and 2000 there was a 5-fold increase in the number

of people incarcerated in the U.S. This increase was not associated with a proportional decrease in crime or drug use. While many originally saw the increase in incarcerations as evidence of a positive effect, contemporary views can see the societal consequences of incarceration for minor drug offenses (Moore & Elkavich, 2008). Drug charges and incarceration were disproportionately issued to minority offenders, which devastated families and communities and perpetuated inequality (Barry, 2019).

Impact of Cannabis on the Body

The second movement associated with modern cannabis debates emerged from the push for medicinal use of cannabis. Starting in the 1960s, researchers began to untangle the complex impact of cannabis on the body (Gaoni & Mechoulam, 1964). The effect that cannabis has on the body works through natural cannabinoid receptors. Within the human anatomy, there are two known cannabinoid receptors. The first receptor is found in the brain. Cannabis's effects on this receptor are responsible for the shifts in memory, coordination, movement, and appetite that are typically associated with a cannabis "high." The second cannabinoid receptors are found in the spleen, gastrointestinal system, testes, and peripheral nervous system. In most cases, cannabinoids located in the peripheral nervous system are the target medicinal therapies (Weiss, Howlett, & Baler, 2017). Currently cannabis is prescribed as a treatment for a host of infirmities, however, few of the current practices are supported by strong evidence of any significant effect. Chronic pain, neuropathic pain, and multiple sclerosis are currently among the infirmities where cannabis has been found to be an effective treatment (Hill, 2015). As legitimate medical uses of cannabis were discovered, the

classification of cannabis as a Schedule 1 substance came under debate. This evidence directly opposed the third requirement for substances classified as Schedule 1 substance; cannabis had substantiated medical use. With this one tenet under debate, it permitted the other two statutes to be openly debated as well; (1) perceived harm and (2) potential for abuse.

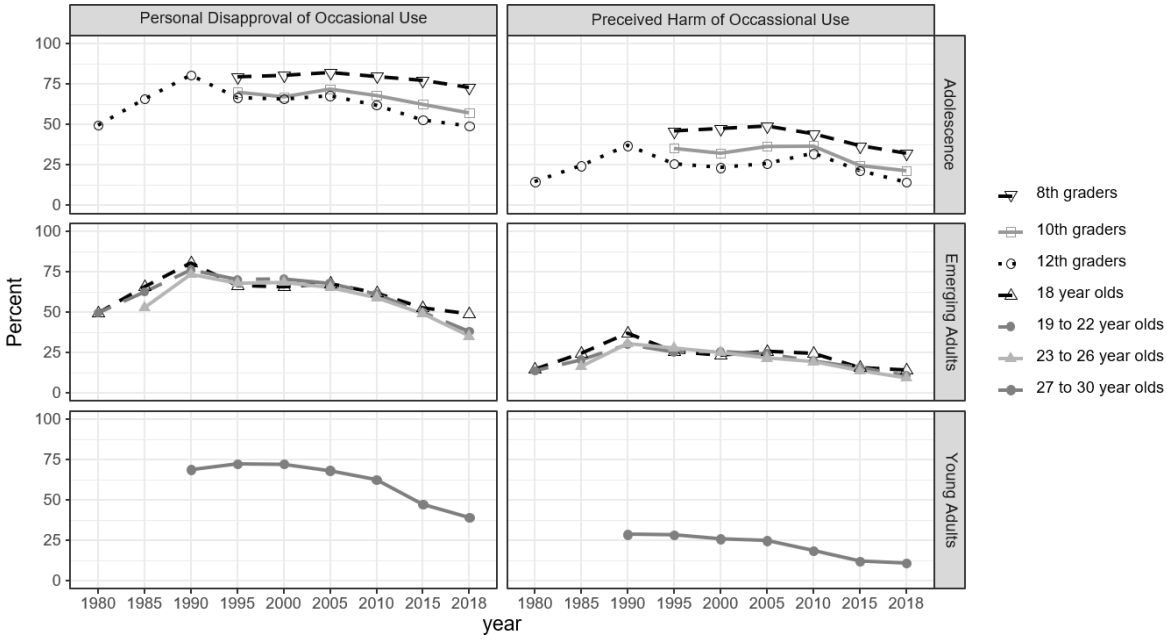
Perceived Harm

Social attitudes and cultural norms around cannabis use are evolving rapidly in the U.S. Figure 2.1 utilizes data from Monitoring the Future between 1980 and 2018 to illustrate changing disapproval and perceived harm of cannabis use. Between 1980 and 1990, there was a steady increase in the disapproval and perceived harm among emerging adults aged 18 to 30. But, since 1990, there has been a steady decrease in disapproval and perceived harm. Currently, disapproval of occasional cannabis use hangs around 30% for emerging and young adults, the lowest it has been in almost four decades. Adolescents are more disapproving of occasional cannabis use, but this trend in disapproval decreases with age. 75% of 8th graders disapproved of occasional use, but only half of 12th graders disapproved. In 2018, perceived harm of occasional cannabis use was around 25% for adolescents and 12% for emerging and young adults.

This trend in decrease perceived harm and disapproval is disconcerting because perceived risk has been shown to foreshadow use, such that, decreases in risk perception predicted increases in future cannabis use. In a longitudinal study, adolescents were

Figure 2.1

Trends in Disapproval and Perceived Risk of Cannabis Use across Monitoring the Future Cohorts by Age



Note. Data obtained from Miech et al. (2020) and Schulenberg et al. (2019).

questioned regarding perceived risk and frequency of cannabis use. Using an autocorrelative, longitudinal structural equation model, researchers identified that shifts in perceived risk were significantly associated with next wave changes in frequency of cannabis use during later adolescence. As adolescent perception of risk decreased, future cannabis use increased (Grevenstein et al., 2015). In fact, Monitoring the Future has theorized that the decreases in perceived risk and harm are directly associated with the national dialog about medical and recreational legalization in the nation. In their opinion, the declines across age groups reflect a period effect.

Period effects—systematic changes in population attitudes, beliefs, and behaviors across time—are identifiable through epidemiological tracking. Starting in 2006,

Monitoring the Future has captured steep changes in attitudes, beliefs, and behaviors regarding cannabis. In 2006, 55-58% of the entire sample endorsed cannabis use as having a "great risk," by 2017, only 23-27% believed so. During this same timeframe, use for high schools increased from 14.2-18.3% to 16.7-22.2% and for young adults from 15.7-24.1% (Hamilton et al., 2019; Schulenberg et al., 2019).

Life course theory perceives period effects as an important tenet of the theory. A major theoretical pillar of life course theory proposes that individual choices are influenced by socio-historical forces, including period effects. Socio-historical influences are stratified over the life course, they offer a broad lens through which researchers can understand and conceptualize individual, group, and societal paths. This element of life course theory has been described as "historical events and institutional arrangements [that] shape life pathways and individual biographies" (O'Rand, 1996, p. 1,889). The historical and institutional arrangements pertaining to substance misuse indeed contribute to individual pathways. Given that this contemporary era of decreased perceived risk and disapproval are synchronized with national discussions and drastic shifts in cannabis policy, exploring the consequences of cannabis use is timely and pertinent.

In a cross-sectional survey comparing eighth graders' attitudes and cannabis use patterns before and after the legalization of medical cannabis (between 1991 and 2014), researchers found an increase in perceived risk following legalization. The increase in perceived harm was associated with lower levels of cannabis use. When the results were stratified by perceived harm, youth with the highest perception of harm were the least likely to use cannabis (Keyes et al., 2016). Similar findings were seen with the

legalization of recreational cannabis. Adolescents in states with legal recreational cannabis perceived higher risk and had lower levels of cannabis use among young adolescents (Estoup et al., 2016). Estoup et al. hypothesize that the national dialog opens the opportunity and necessity for family dialog about cannabis use. The family dialog may influence the perceived harm and a determination to not use. It is important to note that the steepest change in Monitoring the Future data among adolescence is between the 8th- and 10th-grade cohorts (see Figure 2.1). It is unclear if the increase in perceived risk and decrease in use in 8th grades will withstand the transition in attitudes and behaviors of the typical 10th-grade cohort.

Another cross-sectional study surveyed 12th-grade students in the U.S. They were questioned regarding their current substance use behaviors and future intents to use cannabis if it became legal. When adolescents were asked to speculate about their intent to use if cannabis became legal, 10% of noncannabis using adolescents reported an intent to initiate if cannabis became legal. For current cannabis users, 18% reported an intent to use cannabis more frequently if it became legal. Within the analysis higher intentions to use were greatest among traditionally at-risk groups; male, Caucasians, and cigarette smokers. Interestingly, several subgroups of adolescents typically at lower risk of cannabis use (noncigarette-smokers and religious adolescents) reported intentions to use if cannabis became legal (Palamar, Ompad, & Petkova, 2014). It is possible that the legalization of recreation cannabis may create new populations of users.

Younger adolescents appear to strengthen their nonuse attitudes and behaviors, but by 12th-grade youth see it as a viable behavior for their future. The decisions made

during adolescence may influence their developmental trajectory, and evidence exists that the discussions and reformation surrounding cannabis policy influence these paths. Research considering emerging and young adult populations during the time of medical and recreational cannabis debate and policy reformation adults trended towards lower perceived risk and disapproval. In states where medical cannabis became available, adults decreased in perceived harm and increased use of cannabis. One study suggested a 1.10 increase in the relative risk of cannabis use among adults in states where medical cannabis became available. The study also found no association with cannabis use disorders (Compton, Han, Jones, Blanco, & Hughes, 2016). Another study found the odds of use to be 1.92 times higher among adults who lived in states with recreational cannabis. However, this finding may be associated with an increase in users in those states as the rate of abuse is similar to rates of abuse among users in other states (Cerdá et al., 2012).

The potential consequences of cannabis policy changes on adolescent, emerging adult, and young adult populations are still unclear. Currently, the state of the research is associated with quantifying trends and associations between policy and behaviors. Research has not yet been able to quantify longitudinal impacts of cannabis use and cannabis policy on developmental outcomes. Understanding the impact of cannabis use on development are necessary both to evaluate and inform policy.

Concurrently with the changing attitudes, believes, and behaviors surrounding cannabis in the U.S. researchers are also developing a robust understanding of the true harms associated with cannabis. Several acute and chronic adverse consequences have

been established. The acute effects of cannabis associated with intoxication or the "high" are well-documented: relaxation, appetite stimulation, heighted sensation, impairment of balance and motor coordination, increased heart rate, impairment of short-term memory and learning, interference with executive function, including judgement and decision-making (Volkow et al., 2014). Cannabis also contributes to mental health disturbances, including short-term and chronic psychosis and paranoia (Krebs et al., 2019; Volkow et al., 2016).

Less well-established are long-term developmental consequences of cannabis use. In a study that combined three large, long-running studies on adolescent and emerging adult health from Australia and New Zealand, researchers considered the sequelae of cannabis use starting in adolescence. They identified significant negative impacts young adult outcomes of educational attainment, addiction, and suicide attempts, but not depression or welfare dependence (Silins et al., 2014). Furthermore, this analysis revealed that young adult outcomes were dose dependent. The discrepancy in outcomes were smallest for occasional adolescent use and largest for daily adolescent users.

In a similar study, researchers estimated young adult outcomes at age 25 based on cannabis consumption during adolescence and emerging adulthood. While controlling for extensive sociodemographic characteristics, the study identified lower education attainment and reduced income for heavier cannabis users. Furthermore, cannabis users experienced higher rates of requiring government welfare assistance, a greater likelihood of relationship dissatisfaction, and a lower perceived life quality (Fergusson & Boden, 2008).

Policy Implications

Updating drug policy is desirable, and significant change is indeed warranted; however, there is a real concern when policy changes are hurriedly implemented without sufficient input from the medical, scientific, and policy research communities. Without careful consideration of short- and long-term consequences associated with policy change society will likely see a magnified negative impact of more liberal cannabis use. To minimize the risk, science must be central in discussions regarding cannabis policy. There are still substantial unknowns about the long-term impacts of cannabis use, especially as they are associated with psychosocial outcomes. The natural consequences of cannabis use often concentrated during the sensitive developmental periods of adolescence and emerging adulthood, of learning, memory, and attention could alter how individuals are able to become self-sufficient adults.

Even though the long-term impacts of cannabis use remain unclear, public opinion of risk is rapidly decreasing. Evidence suggests that as perceived risk decreases, cannabis use will increase (Keyes et al, 2011; Parker & Anthony, 2018; Schulenberg et al., 2019). With the real prospect of more states legalizing cannabis and more individuals using, it is necessary that policymakers recognize that there remain substantial unknowns surround the impact of widened cannabis use. Policymakers should have an eye towards regulating advertising, earmarking funds for continued research, championing responsible use, and supporting addiction prevention and recovery efforts.

Research Design

The present study investigated the reported changes in substance misuse between adolescence, emerging adulthood, and young adulthood and explored how these changes were associated with young adult outcomes. The research presented here considers differences in substance misuse patterns. It specifically considered those who had periods of substance misuse but matured out by young adulthood, those who continued use into young adulthood, and those who did not report misuse. These substance use patterns were explored for relationships with young adult self-sufficiency outcomes.

Paths from adolescent dependence to young adult self-sufficiency are complex and diverse. While the end goal is well-functioning adulthood, successful adulthood is difficult to quantify. Self-sufficiency reflects autonomy in action and thought, responsibility, and financial independence (Arnett, 1998, 2000a). Prior development paves the path to self-sufficiency, highlighting the importance of adolescent and emerging adult development in the acquisition of adulthood. Despite the influence of previous development on current and future development, few studies weave together these developmental periods. This research was able to consider data across the developmental periods using extant, nationally representative data and advanced analytic techniques.

Anthony et al. (2016) notably stated,

> Now is the time for public health scientists of the future to make their research follow the contours of the human experience as has been learned from multiple drug surveillance projects… [W]here the human experience has the character of polydrug use it makes more sense to study antecedents, suspected correlates and causes, and consequences of drugtaking in the polydrug mode. (p. 54)

The design of the current research sought to align with the human experience by considering substance misuse through a life course developmental lens. It was important to recognize that the human experience with substance use should be considered in terms of trajectories, misuse contexts, historical trends, and relevant developmental outcomes. Specifically, this research conceptualized substance misuse longitudinally and developmentally. Three measurement occasions were spread to reflect developmental changes in polysubstance use as participants transitioned to adulthood. Although polysubstance use best reflects use patterns in the U.S., it is often overlooked in research in favor of parsimony (Anthony et al., 2016). By considering polysubstance use in the general population, this research better reflects the human experience associated with substances and constructively adds to our understanding of the impact of substance misuse. Specifically, this research provided a view of substance use patterns across development and how individuals transition between substance use patterns using an LMM.

Historical contexts inspired the focus on maturing out of substance misuse and exploring the impact of continued cannabis use into young adulthood. The growing recognition of an extended developmental period between adolescence and young adulthood (emerging adulthood) merits additional substance misuse research. Given that this developmental period contains both the peak of substance misuse and many time-sensitive opportunities it is possible that substance misuse patterns impact trajectories into adulthood. Changing cannabis policy highlights the importance of understanding substance misuse patterns on young adult outcomes. Current trends in policy and public

opinion are increasing accessibility and acceptability of regular cannabis use. Unfortunately, there is not a clear consensus on the long-term impacts of regular cannabis use into young adulthood on key young adult outcomes.

Finally, this research builds on current knowledge by considering relevant young adult outcomes during the relevant developmental stage. As the transition to adulthood has extended the time to take on adult roles, long established indicators of adulthood (milestones of marriage, parenthood, career, and home ownership) have been replaced by more intrinsic markers of adulthood. These intrinsic markers of adulthood have been summarized as self-sufficiency or the ability to stand alone. Indeed, self-sufficiency may be a better conceptualization of what is required for adulthood.

This research contributes to science by identifying how substance misuse during developmentally sensitive periods may impact young adult psychosocial outcomes. The findings from these analyses benefit public health by addressing substance misuse (a major public health issue), isolating the effect of cannabis use (a point of changing policy), and providing information that could be leverage in intervention and policy.

Research Questions

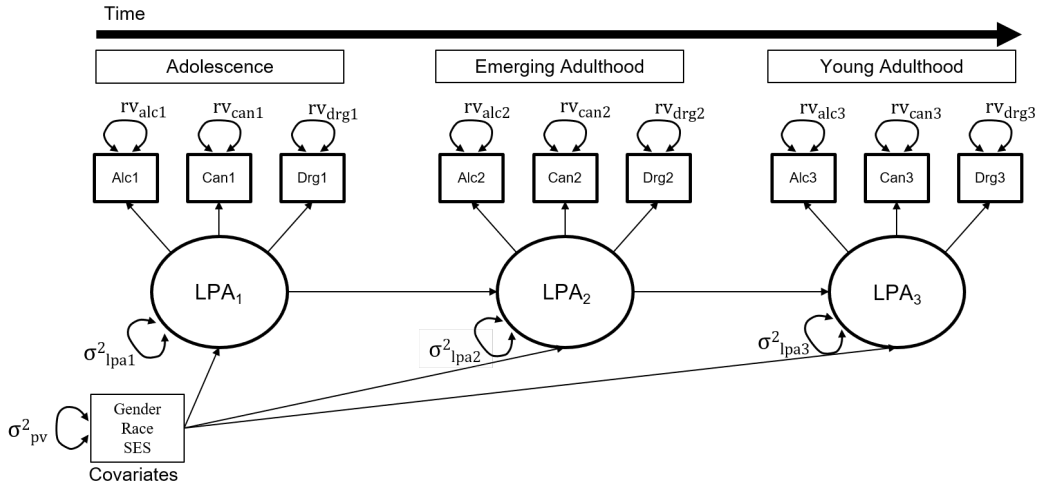
Research Question 1. To what extent do individuals transition between substance misuse patterns across adolescent, emerging adult and young adult development?

Hypothesis Research Question 1. It was anticipated that substantial transitions in substance behaviors would be seen across development. It was expected that many individuals would transition from no-to-low misuse to higher levels of misuse use

between adolescence and emerging adulthood. It was expected that many individuals would transition from high levels of misuse use to no-to-low misuse by young adulthood, evidencing a maturing-out of substance misuse. Model diagram can be seen in Figure 2.2.

Figure 2.2

Diagram of the Longitudinal Mixture Model (LMM) with Incorporation of Covariates for Answering Research Question 1



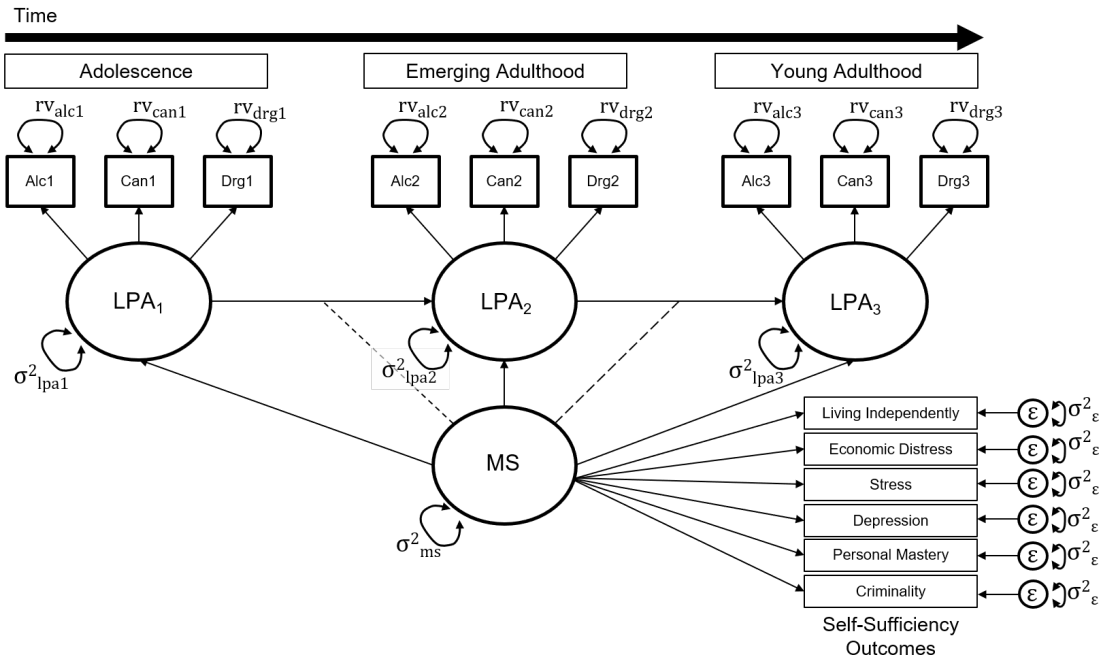
Note. Alci = Alcohol consumption at developmental period i Cani = Cannabis consumption Drgi = Illicit drug consumption LPAi = Latent profile analysis for each developmental period rvi = independent variable residual variance 2i = latent class variance.

Research Question 2. Do transitions in substance misuse influence young adult developmental outcomes of self-sufficiency?

Hypothesis Research Question 2. It was hypothesized that individuals who do not mature out of substance misuse patterns by young adulthood would have poorer young adult self-sufficiency outcomes compared to individuals who maintain a no-to-low misuse pattern across. It was expected that matured-out users would have similar self-sufficiency outcomes compared to individuals who maintained a no-to-low misuse pattern. A model diagram for Research Question 2 can be seen in Figure 2.3.

Figure 2.3

Diagram of Mover-Stayer (MS) Model with Incorporation of Distal Outcomes for Answering Research Questions 2 and 3. For Research Question 2, MS was Divided to Have 3-Profiles. For Research Question 3, MS was Defined to have 4-Profiles



Note. Alci = Alcohol consumption Cani = Cannabis consumption Drgi = Illicit drug consumption LPAi = Latent profile analysis for each developmental period rvi = independent variable residual variance 2i = latent class variance = Dependent variable error development or to individuals who matured-out of substance misuse by young adulthood.

Research Question 3. Does stable cannabis use influence young adult developmental outcomes of self-sufficiency?

Hypothesis Research Question 3. It is anticipated that individuals who maintain risky substance misuse patterns through young adulthood will have poorer adult outcomes compared to participants who maintained a no-to-low misuse pattern, matured-out, or who continued using as cannabis-only users. It is anticipated that there will not be statistically significant difference between stable cannabis users and matured out users. Research Question 3 can also be seen in Figure 2.3. The difference in the model between

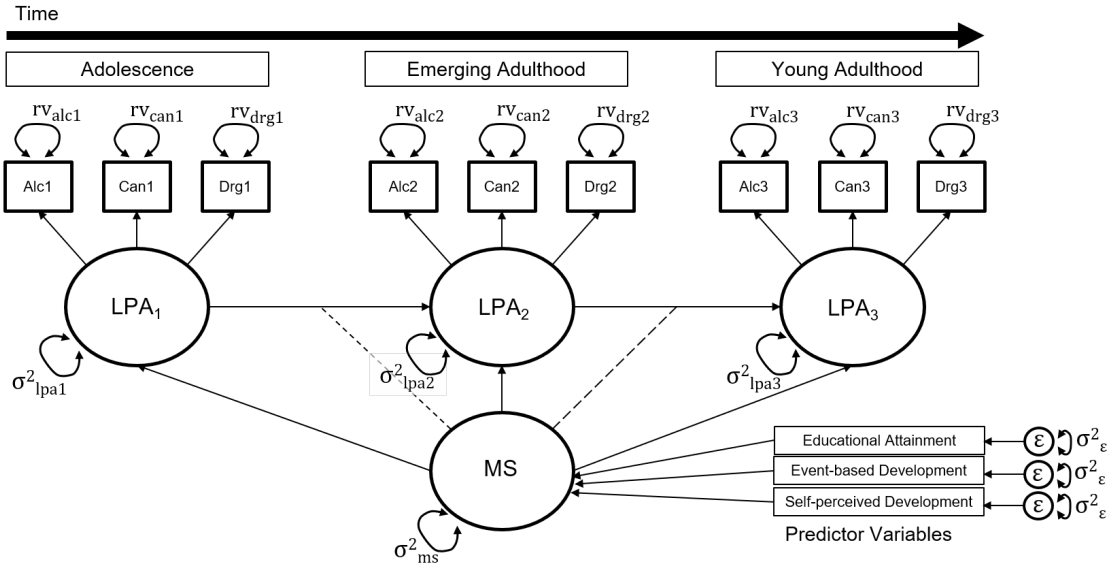
Research Questions 2 and 3 is the number of MS profiles specified. In Research Question 2 three MS profiles are specified, in Research Question 3 four MS profiles are specified.

Research Question 4. What is different between individuals who age out and those who maintain patterns of risky use compared to those who did not misuse substance?

Hypothesis Research Question 4. Significant differences are expected to exist between those who mature out and those who continue to misuse substances. There will be differences based on education attainment, event-based adult indicators, and perceived adult status between longitudinal pattern of misuse. The model for Research Question 4 can be seen in Figure 2.4.

Figure 2.4

Diagram of Mover-Stayer (MS) Model with Incorporation of Distal Outcomes for Answering Research Question 4. For Research Question 2, MS was Divided to Have 3-Profiles. For Research Question 3, MS was Defined to have 4-Profiles.



Note. Alci = Alcohol consumption Cani = Cannabis consumption Drgi = Illicit drug consumption LPAi = Latent profile analysis for each developmental period rvi = Independent variable residual variance 2i = Latent class variance = Predictor variable error.

CHAPTER 3

RESEARCH DESIGN AND METHODS

The purpose of this study was to examine substance misuse across adolescence, emerging adult, and young adult development to deepen our understanding of the life course impact of substance misuse. Specifically, this proposed project investigated how individual patterns of substance misuse change across development and what those changes mean for young adult self-sufficiency. The present study used extant data from the National Longitudinal Study of Adolescent Health (Add Health; Harris et al., 2009) to study substance misuse across development.

The Add Health data is a large, longitudinal, and nationally representative sample from the U.S. dedicated to studying adolescent and adult health. It contains four complete waves of data collection that span 14 years and a fifth wave that followed a subset of the original participants. Details regarding Add Health data, sampling, design, and procedures are discussed elsewhere (Harris et al., 2009). Briefly, Add Health used systematic, stratified sampling to capture a nationally representative sample of adolescence at the first measurement occasion. Participants were surveyed on four occasions: wave I in 19941995, wave II in 1995-1996, wave III in 2002-2003 and wave IV in 2007-2008. At the first survey occasion, participants were between the ages of 10 and 21. By the fourth survey occasion, participants were between the ages of 23 and 34. While the Add Health dataset contains data from five collection periods, the current research only used data from waves I, III, and IV. These waves best captured substance misuse behaviors at three developmental periods; adolescence, emerging adulthood, and

young adulthood. Wave I was selected over wave II because wave I was more complete. In wave II, youth who had graduated high school were not proactively retained, resulting in a loss of data (Add Health, 2018, slide 6). By wave III, the recruitment strategy expanded to contact all students who participated in wave I. The active retention plans in the later waves resulted in an 80.3% retention rate between the first and fourth survey occasion (waves I and IV, respectively; Harris, 2013).

For the intent of this research, Add Health was an ideal data source to show long-term patterns of substance misuse that span developmental periods. It also contains social, behavioral, and contextual data at each survey occasion. The robustness of the dataset, combined with the longevity of the study are key to determine patterns of substance misuse from adolescence through young adulthood, investigate transitions between patterns of substance misuse, and estimate the impact of substance misuse on adult self-sufficiency.

Participants and Procedures

Add Health participants were first recruited for wave I in 1994-1995. The design used systematic, stratified sampling to invite high schools to participate in the study (Harris, 2013). Schools were eligible for participation if they had an 11th grade and more than 30 students. Schools were stratified by region, urbanicity, school type, demographic characteristics, and size. Ultimately, 80 high schools were selected for participation in the study. All students in the participating high schools were surveyed in-school and a subsample was selected for the longitudinal

in-home survey. In-home survey participants were selected using random-weighted techniques to recruit participants that were representative of national demographics. Youth with expected high-attrition rates were oversampled. Demographics from the first survey occasion are displayed in Table 3.1. The first survey occasion included in-home interviews with 20,754 participants. Participants' average age was 16.1 (*SD* = 1.81) years old. The sample was 50.2% female. Median maternal education of the sample is "some post-secondary training," which included parents who began post-secondary training at a college, university, or trade school but did not complete their degree. A small proportion of participants were currently receiving

Table 3.1

Participant Demographics Measured at the First Survey Occasion, Wave I

Demographics	*M*	*SD*	*N*	%
Age (years)	16.1	1.81		
Female				50.2
Mother's education				
Less than high school			3,040	14.7
High school or GED			5,270	25.4
Some post-secondary			3,460	16.7
Completed post-secondary			4,193	20.2
Beyond bachelor training			1,564	7.5
Missing			3,199	15.4
Family receiving welfare			1,701	8.2
Hispanic			8,467	16.4
Race				
Caucasian			11,917	57.5
African American			4,389	21.2
Asian-American			1,356	6.5
Native			240	1.2
Multi-racial			1,064	5.1
Other			1,705	8.2
Missing			74	0.4

Note. N = 20,739.

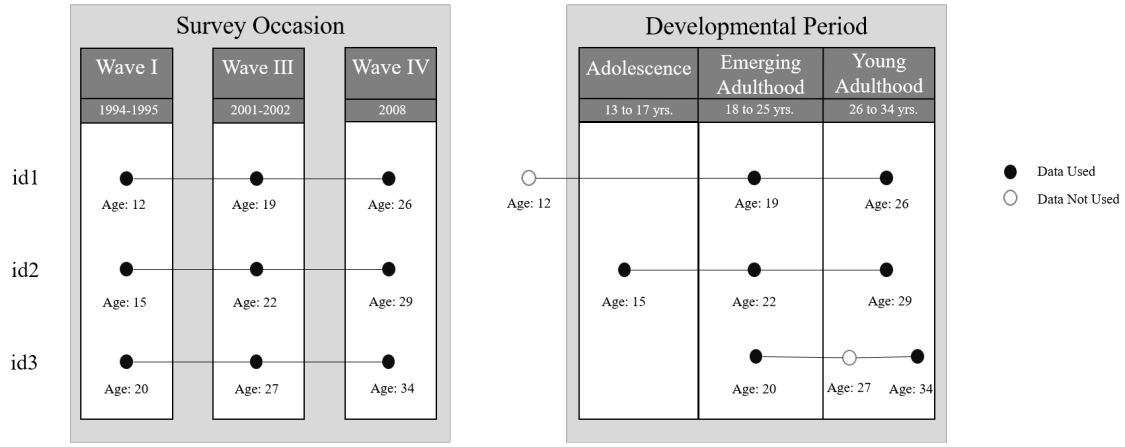
welfare, 8.2%. Participants were predominantly white (57.7%) and include various other races; African American (21.2%), Asian-American (6.5%), multi-racial (5.0%), and other (9.4%).

For the intent of this analysis, data required restructuring to allow the developmental period to serve as the indicator of time. The original dataset was temporally organized by survey occasion. Within each survey occasion, many developmental periods were represented (e.g., the age range for wave I was 12 to 21), adolescent and emerging adult developmental periods were represented in wave I. To organize the data temporally by developmental period, it was necessary to transform the dataset using an accelerated cohort design. The aim of an accelerated cohort design is to estimate longitudinal, age-related outcomes (Miyazaki & Raudenbush, 2000). The change from a survey occasion design to an accelerated cohort design by developmental period can be seen in Figure 3.1.

The data were organized so that the first developmental period was adolescence, data from this first timepoint included measures that occurred when a participant was between the age of 13 and 17. The second developmental period became emerging adulthood, this period included data collected when participants were between the ages of 18 and 25. The final timepoint was young adulthood. This timepoint included all data collected when participants were between the age of 26 and 34. This design, created additional missingness since not all participants contributed to each developmental period. Figure 3.1 will be used to illustrate three examples. First, example id1 was 12 at the first survey occasion (wave I) by the final survey occasion id1 was 26 years old. In

Figure 3.1

Illustration of the Accelerated Cohort Transformation from a Survey-Occasion Design to a Developmental Period Design



the accelerated cohort design, id1 does not contribute to the adolescent developmental period, but does contribute to emerging adulthood and young adulthood. The individual represented by id2 has survey occasions and developmental periods that align neatly. Data from sample id3 does not contribute to adolescence and has two available responses during young adulthood. Where two available survey occasions fall in the same developmental period, the older of the two occasions was selected. **Table 3.2** contains the number of participants from each survey occasion contributing to each developmental period. The total, unduplicated sample at each developmental period was 15,400 for adolescence, 16,749 for emerging adulthood, and 15,632 for young adulthood.

Table 3.3 displays the demographics of the participant populations following the accelerated cohort transformation. Note, all demographics were measured at the first survey occasion (wave I), there was overlap where participants contribute to multiple

Table 3.2

Number of Participants from Survey Occasions Contributing to Developmental Period in the Accelerated Cohort Design

	Developmental period			
Survey occasion	Adolescence	Emerging adult	Young adult	Total
Wave I	15,400	5,319	0	20,719
Wave III	0	14,341	856	15,197
Wave IV	0	38	15,658	15,696
Total	15,400	19,698	16,514	
Unduplicated	15,400	16,749	15,632	

stages. Differences across groups were non-significant for all demographic categories except for Asian-Americans and families receiving welfare. During emerging adulthood, more Asian-Americans contributed data than in the other two developmental periods. Also, during emerging adulthood, fewer families who reported receiving welfare support (as measured at wave I) contributed to the emerging adulthood data point.

Measures

Risky Substance misuse Variables

You cannot have two side headings at different levels right after each other. You need to have some text here that will tell the reader what will follow.

Heavy Drinking

The variable representing heavy drinking was measured at each Add Health

Table 3.3

Participant Demographics Within the Accelerated Cohort Design by Developmental Period

	Developmental period											
	Adolescence (*n* = 15,400)				Emerging adult (*n* = 16,749)				Young adult (*n* = 15,623)			
	M	*SD*	*n*	%	*M*	*SD*	*n*	%	*M*	*SD*	*n*	%
Age (years)	15.4	1.3			21.2	2.3			29.0	1.7		
Female			6,883	51.5			8,158	48.2			6,487	47.4
Mother's Education												
Less than high school			2,188	16.2			2,944	17.4			2,244	16.4
High school or GED			4,089	30.3			5,007	29.6			4,135	30.2
Some post-secondary			3,975	29.5			5,008	29.6			4,050	29.6
Completed post-secondary			1,963	14.6			2,392	14.1			1,982	14.5
Beyond bachelor training			1,248	9.3			1,546	9.1			1,267	9.3
Missing			14	0.1			20	0.1			17	0.1
Family receiving welfare			1,359	10.1			1,458	8.7			1,220	9.0
Latinx			2,108	15.6			2,761	16.3			2,149	15.7
Race												
White			8,708	64.6			10,846	64.1			8,940	65.3
African American			3,107	23.1			3,695	21.8			3,039	22.2
Asian American			755	5.6			1,134	6.7			772	5.6
Native			521	3.9			599	3.5			488	3.6
Other			1,153	8.6			1,515	9.0			1,189	8.7

survey occasion. Heavy drinking was reflected from a single item that asked participants how often they drank 5 or more drinks on a single occasion in the past year. Heavy Drinking was measured on a seven-point scale; 0 = no heavy drinking in the past year, 1 = less than monthly, 2 = once a month, 3 = 2 or 3 times a month, 4 = 1 or 2 times a week, 5 = 3 to 5 days a week, 6 = every day or almost every day.

Cannabis use. Cannabis use was measured with a single item that asked about participants' use of cannabis over the past 30 days. Across the duration of the Add Health project, the item had slight variation in scoring. In survey occasions I and III, participants

wrote in the number of times they used cannabis. In survey occasion IV, cannabis use was measured on a 7-point scale. For uniformity, cannabis use at each time-point was recoded to reflect past month use on the 7-point scale used during survey occasion IV; 0 = no cannabis use in the past year, 1 = once a month or less, 2 = 2 or 3 times a month, 3 = 1 or 2 times a week, 4 = 3 to 5 days a week, 5 = every day or almost every day, 6 = multiple times a day.

Illicit drug use. Illicit drug use items varied between Add Health survey occasions. During survey occasions I and III, several items contributed to the constructed illicit drug variable used in these analyses. Questions that asked about illicit drug use were summed and recoded to reflect use in the past month. During survey occasion I, items asked specifically about cocaine use in the past 30 days and "other drug" use in the past 30 days. Other drug use was explained as LSD, PCP, ecstasy, mushrooms, speed, ice, heroin, or pills not prescribed by a doctor. During survey occasion III, participants were specifically asked about their cocaine, meth, and "other drugs" use during the past 30-days in three unique questions. During survey occasion IV, only a single question captured illicit drug use. Participants were only asked about their "favorite" drug. Respondents indicated their "favorite" drug and their use of their "favorite" drug in the past month. The (summed) variable was recoded to a 7-point scale; 0 = no illicit drug use in the past year, 1 = once a month or less, 2 = 2 or 3 times a month, 3 = 1 or 2 times a week, 4 = 3 to 5 days a week, 5 = every day or almost every day, 6 = multiple times a day. Table 3.4 displays number and proportion of participants using substance at differing levels across adolescent, emerging adult, and young adult developmental periods. Figure

3.2 provides a graphic description of the proportion of participants misusing alcohol, cannabis, and illicit substances at the different developmental periods.

Table 3.4

Substance Use Percentages by Developmental Period

Substance by developmental period	Code value / Text label	0 None	1 < 1/mth	2 2-3/mth	3 Weekly	4 2-3/wk	5 4-6/wk	6 > daily	Median	
		%	%	%	%	%	%	%	All	Users
Adolescence (*n* = 15,400)										
Heavy alcohol		43.0	20.8	3.7	2.7	2.3	1.1	0.8	0	1
Cannabis		54.5	11.4	2.4	1.6	0.6	1.4	1.1	0	1
Illegal drugs		67.7	3.1	1.2	0.6	0.2	0.4	0.3	0	1
Emerging adulthood (*n* = 16,749)										
Heavy alcohol		22.7	31.3	8.3	7.2	7.7	2.8	0.8	1	2
Cannabis		52.0	13.7	3.7	2.6	1.0	3.4	3.8	0	2
Illegal drugs		69.8	6.5	2.1	1.0	0.4	0.5	0.4	0	1
Young adulthood (*n* = 15,632)										
Heavy alcohol		21.1	31.4	8.0	6.3	5.6	2.2	0.7	1	1
Cannabis		58.9	6.9	2.1	0.6	1.3	2.0	3.8	0	2
Illegal drugs		68.2	4.3	1.2	0.4	0.5	0.5	0.6	0	1

Young Adult Self-sufficiency Variables

Self-sufficiency was described in the literature as autonomy in thought and decision-making, personal responsibility, and financial independence (Arnett, 1997, 1999, 2000a; Nelson & Barry, 2005; Whittington & Peters, 1996). Several constructs that reflected personal self-sufficiency were identified in the Add Health dataset; central statistics were presented in Table 3.5. All measurements occurred during the last measurement occasion (wave IV). Responses from this last measurement were excluded if the participant had not yet reached young adulthood.

Figure 3.2

Substance Misuse by Developmental Stage and Substance

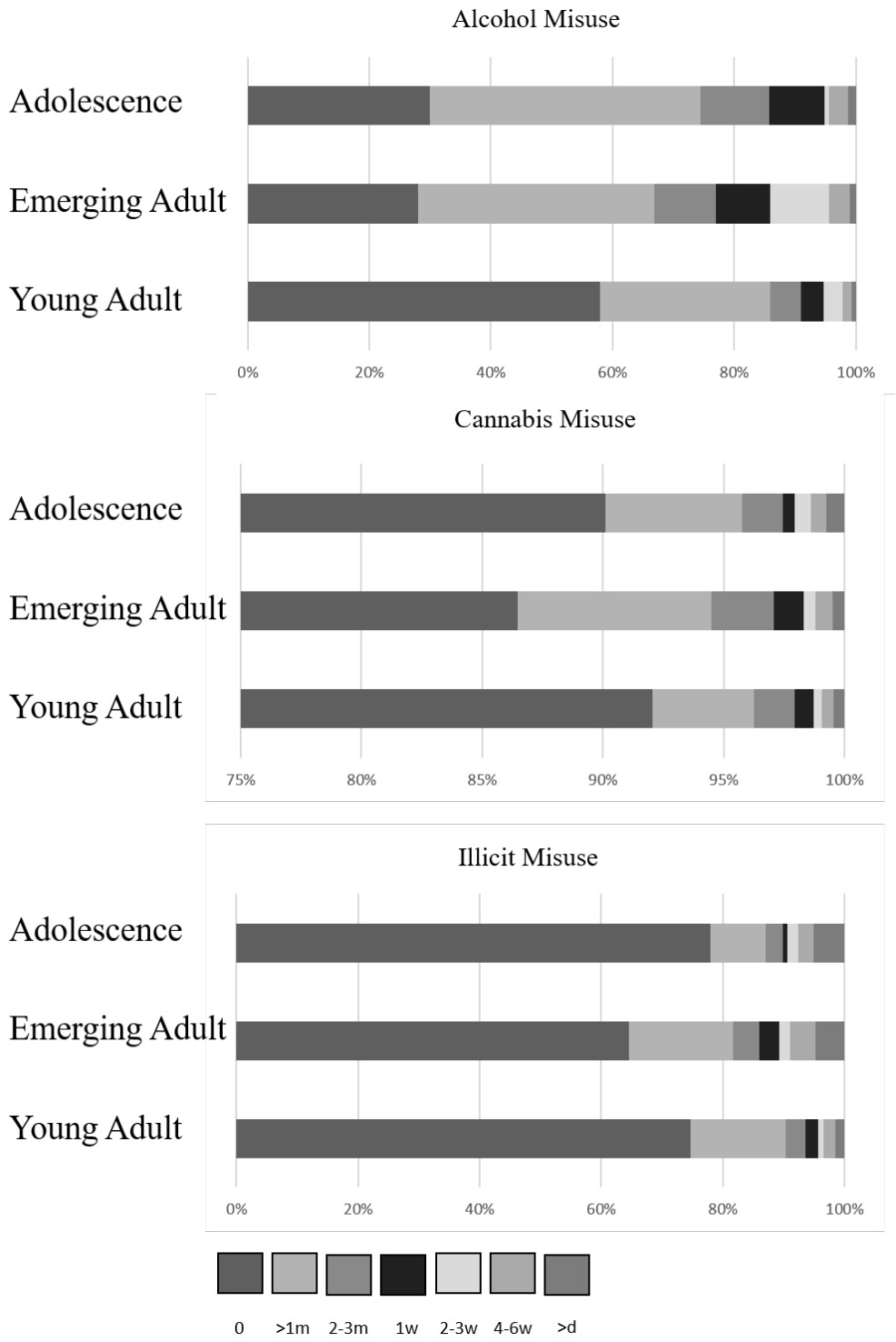


Table 3.5

Young Adult Self-Sufficiency Distal Outcomes Collected at Wave IV

Self-sufficiency operationalized	*N*	*n*	%	Mean	Median	*SD*	Min	Max
Autonomy								
Personal mastery	15,104			19.5		2.9	5	25
Stress	15,129			4.8	5.0	4.0	0	16
Personal responsibility								
Criminal behavior	15,091	5,553			5.0	4.0	0	30
Financial independence								
Economic distress	15,099	10,822			0.0	1.1	0	7
Living independently	15,087	11,585	78.6					

Note. Mean used for roughly normally distributions, median use when data are skewed.

Autonomy

The construct of autonomy is measured through self-perceived personal mastery and stress. The final survey occasion (wave IV) contained a five-item scale of personal mastery and a four-item scale for stress. Personal mastery reflected a personal sense of autonomy over one's life. Example items included, "There is little I can do to change the important things in my life" and "Other people determine most of what I can and cannot do." Responses ranged from 1 = strongly disagree to 5 = strongly agree. The mastery items were coded such that lower scores reflected lower personal mastery, while higher scores reflect higher personal mastery. The 5-items were summed; scores ranged between 5 and 25, having a mean of 19.5 (*SD* = 2.9).

The four-item stress scale measured current personal capacity to handle life's stresses. All questions were phrased to reflect stresses experienced in the past month. Example items included, "how often have you felt that you were unable to control the important things in your life" and "how often have you felt that things were going your

way?" Responses ranged from 0 = strongly disagree to 4 = strongly agree. The four-items were summed; low scores reflected less personal stress, while high scores reflect more stress. Scores ranged from 0 to 16 and was skewed towards less stress. Together these two scales provided a partial view of autonomy. Personal mastery reflected a relatively stable perception of autonomy with a non-time bound question and stress provided a fluid view of autonomy honing responses to the past month.

Personal Responsibility

The construct of personal responsibility was measured with the proxy variable of criminality. During the last measurement occasion, participants were asked about their involvement in a variety of criminal behaviors. Responses to these questions fell into one of three categories, 0 = not involved in this criminal behavior, 1 = involved in this criminal behavior only once in the past year, and 2 = involved in this criminal behavior more than once in the past year. Sample items include, "how often did you deliberately write a bad check?" and "how often did you buy, sell, or hold stolen property?" The 10-items were summed, the response ranged from 0 criminal behaviors to 30 criminal behaviors. Higher scores reflected greater involvement in criminal behaviors and lower scores reflected lower levels of criminal behavior. Eighty-four percent of the sample (12,677 participants) were not engaged in any criminal behaviors during young adulthood. Approximately 7.3% (1,096 participants) were engaged in just one criminal behavior during the past 12 months. As the number of criminal behaviors reached five criminal acts, the percentage of participants dropped below 1%. In total, 295 young adult participants engaged in 5 or more criminal acts.

Financial Independence

Financial independence was measured with a scale that reflects economic distress and a single item inquiring about independent living. During the final measurement occasion participants were asked about personal financial difficulty over the past year. Seven dichotomous items were summed to create the variable reflecting economic distress. Each item was scored either 0 = event not experienced or 1 = event experienced. The aggregated items ranged from 0 7. Those with higher scores experienced more financial distress in the past year. Example questions include, “In the past 12 months, was there a time when you or someone in your household needed to see a dentist, but didn’t go because you could not afford it?” Economic distress was skewed towards no economic distress, with 63.1% of participants (9,530 participants) having no distress. 19.2% of participants (2,904 participants) experienced a single economic distress item. 2.9% of participants (456 participants) experience 5 or more distress items.

Independent living was measured with a single item from the final measurement occasion. Participants were living independently if they indicated they lived at their own place, regardless of whether the participant lived alone or with others (roommates, partners, children). Participants were not considered to be living independently if they lived in their parent’s home, another person’s home, group living quarters, or were homeless. At measurement occasion IV, 78.6% of young adult participants were living independently.

Predictors of Young Adult Substance Misuse Classification

Substance misuse classification may be associated with other participant

characteristics. Educational attainment, event-based developmental outcomes, and self-perceived development were explored as predictors of young adult substance misuse classification.

Educational Attainment

During the final survey occasion (wave IV), participants reported their current highest academic achievement. Possible responses were less than high school, high school degree or GED, some post-secondary training without completion of a degree or certificate, completed post-secondary training (degree or certificate) or more. The median education attainment for participants was completing some postsecondary training without receiving a degree or certificate.

Event-Based Development

At the final survey occasion (wave IV), participants also responded to questions that provided information into several event-based developmental outcomes (homeownership, marriage, and parenthood) to understand the impact of maturing out of substance misuse. Each event was established with a single item. By the final survey occasion, 30% of participants owned a home, 37 % had been married, and 37% were parents. Home ownership could be in the form of a house, condo, or apartment. Ever married included persons who were married or divorced. Parent status referred to participants' interactions with their own biological child(ren) or through marriage, cohabitation, or adoptive relationship. It was not necessary for a participant to reside with the child to be considered a parent.

Self-Perceived Adult Status

During the third survey occasion (wave III), participants responded to question about their perceived adult development as an adult in comparison to same-aged peers. Perceived on-time social development was measured with a single item that asked to rate how fast they grew up compared to their same aged peers. Responses ranged from slower, about the same rate, or faster. Most participants believed they were more social mature than their peers. Fifty-nine percent thought they were more mature, 32% thought they were less mature as their peers, and only 7% believed themselves to be equally as mature. Participants also rated how responsible they believed they were compared to same aged peers. Responses ranged from less responsible, about the same, or more responsible. Sixty-four percent of participants considered themselves to be more responsible than their peers, 27% believed they were less responsible, and 8% believed they were equally mature as their peers. Table 3.6 provides a description of the variables that will be used to predict mover-stayer classification in Question 4.

Covariates

Covariates were integrated into the LMM model using the 3-step approach developed by Asparouhov and Muthén (2014). Age, gender, childhood SES reflected in mother's educational attainment, and race were added to the LMM model as covariates to provide context to the estimated LMM model.

Weighting

Add Health employed an oversampling method for recruitment. Weighting was

Table 3.6

Predictors of Young Adult Substance Misuse Classification in Mover Stayer Model Measured at the Final Survey Occasion, Wave IV

Predictor variables	*N*	*n*	%	Mean	Median	Min	Max
Educational attainment	15,119					0	5
Less than high school		1,252	8.3				
High school or GED		2,565	17.0				
Some post-secondary		5,937	39.3				
Completed post-secondary		4,034	26.7				
Beyond bachelor training		1,331	8.8				
Event-based development						0	1
Home ownership	15,662	6,275	40.0				
Ever married	15,671	7,793	49.7				
Parenthood	15,665	7,848	50.1				
Perceived adult status						0	2
Perceived age	15,159			2.1	2.0		
Social maturity	15,115			2.0	2.0		
Social responsibility	15,127			2.2	2.0		

used to compensate for variable probabilities of selection, differential nonresponse and attrition rates, and possible deficiencies in the sampling frame (Harris, 2013). To align the true sample demographics with population demographics, weights were assigned to adjust for sample over- or under-representation (Chen & Chantala, 2014). This process safeguards the research from selection bias and supports the validity of the findings as they relate to the general U.S. population (Rendtel & Harms, 2009, p. 266). Weights were provided within the dataset for easy incorporation.

Power Estimates

Before conducting the analysis, the power estimates were explored. Add Health included 20,754 participants and made extensive efforts to reduce attrition, resulting in an

80.3% retention rate at the fourth measurement occasion, 12-years later.

The Add Health databased provided a large and sufficiently complete dataset to allow for most analytic techniques. While the sample size is the strongest predictor of power of longitudinal latent models, a large sample size is only a piece of the information considered in power estimates. Model fit, class separation, and latent transition probabilities all contribute to power in longitudinal latent models (Baldwin, 2015). A conservative sample size estimate for a well-defined model, with uneven class sizes and uneven transition probabilities for a 3-class model reaches stability at 1,500 participants (Baldwin, 2015, p. 53). The available sample size in Add Health exceeded the recommended value by 10-fold.

Analytic Plan

Research Question 1

The goal of Research Question 1 was to explore individual movement in substance misuse behaviors across adolescent, emerging adult, and young adult development. While extensive research supports heterogeneity in polysubstance misuse (Merrin & Leadbeater, 2018; Tomczyk et al., 2016), research has not widely investigated the extent to which individuals change substance misuse patterns across time. To accomplish this, an LMM was employed to capture individual movement in substance use patterns across time.

Prior to conducting the LMM, several preliminary latent profile analyses (LPA) were undertaken to enumerate latent classes at each developmental period. LPA are

cross-sectional mixture models that estimate latent profiles from continuous indicator variables (see Figure 2.2). In this dissertation, the latent profiles (LPA1, LPA2, LPA3) were estimated using the three substance use indicator variables (Alci, Cani, Drgi). While the indicator variable means were estimated freely in the LPA models, the variances were constrained to be equal within each LPA (2 LPA1, 2 LPA2, 2 LPA3). Constraining the LPA model to have equal variances is adventitious when exploring rare behavior patterns, like substance misuse. In rare behavior patterns, profiles may have near 0 variance which cause convergence problems (Asparouhov & Muthén, 2019). Constraining the LPA model variance increases the capacity to detect rare behavior patterns, which aligns with the presented Research Questions.

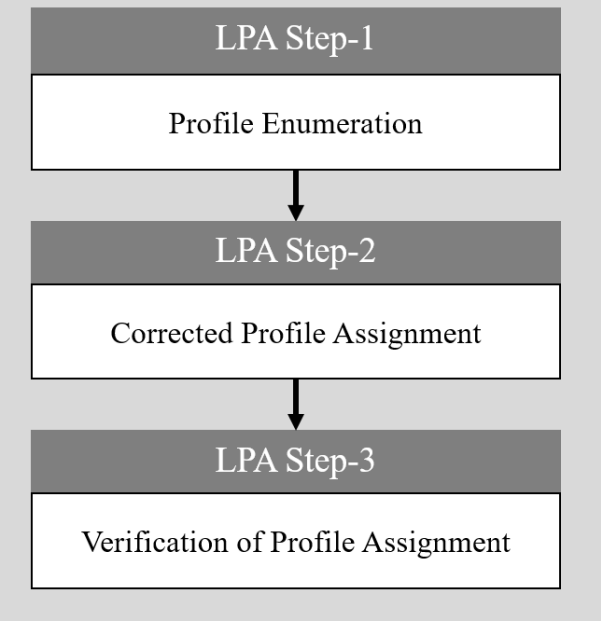
Latent Profile Analysis (LPA)

LPA profile enumeration followed the 3-step approach described by Asparouhov and Muthén (2013). The steps include, (1) profile enumeration, (2) assignment of latent profile membership with a correction for model misclassification, and (3) verification of the LPA model with fixed measurement parameters (Figure 3.3). The step model prepared the LPA for integration into the LMM (Research Question 1) and Mover-Stayer analyses (Research Questions 2 through 4) that followed. This technique protected the LPA formation and meaning from the influence of the secondary models.

Step-1. LPAs are foundational to conducting an LMM. As explained by Specht et al. (2014), “the goal of LPA is to identify different subgroups…whose members are similar to each other and different from members of other groups” (p. 553. As such, an LPA estimates underlying patterns of common behavior within a heterogeneous sample.

Figure 3.3

Flow Chart for the 3-Step Latent Profile Analysis (LPA) Approach



Note. LPA 3-step approach prescribed by Asparouhov & Muthén (2013).

This technique is preferable to indicator specific methods since research has shown that heterogeneity in substance misuse is expected in general populations (Tomczyk et al., 2016).

To explore how individuals move between substance misuse behaviors, independent cross-sectional LPAs were first conducted separately for adolescent, emerging adult, and young adult developmental periods. To surface the appropriate number of underlying profiles, the data were first modeled with only two specified profiles. As the number of specified profiles increased, the bootstrap likelihood ratio test (BLRT) and the Bayesian Information Criteria (BIC) were considered to identify when an estimated model most accurately reflects the data (Nylund et al., 2007). In addition to

considering model fit indices, it was essential to recognize the importance of the substantive meaning of each solution, parsimony, and theory (Bauer & Curran, 2003; Berlin et al., 2014); this was especially necessary as the current analyses had a large sample size. In instances where sample size is large, it is possible to generate more profiles than are theoretically necessary to explain the intended phenomenon. Following the selection of the best models for the underlying data at each timepoint, the most likely class membership variables for each model were saved.

Step-2. In the second step of the 3-step approach, the substance use variables in the best LPA models were substituted for the most like profile membership variable generated in LPA Step-1. Within the LPA model the most likely profile variable was corrected for LPA model misclassification. The LPA model correction was found in the Mplus output labeled as "Logits for the Classification Probabilities for the Most Likely Latent Class Membership (Row) by Latent Class (Column)."

Step-3. The final step of the 3-step approach estimates the LPA model using the corrected most likely profile membership variable in place of the substance use indicator variables. This third step is a check point. The LPA model is checked for similarities in distributions, means, and variances to the LPA model selected in LPA Step-1. An LPA Step-3 models that matches the LPA Step-1 model is ready for the addition of secondary models, covariates, and distal outcomes. An LPA Step-3 model that does not match the LPA Step-1 model should return to LPA Step-1 for improved enumeration.

Longitudinal Mixture Model (LMM)

The intent of this research question was to model person-centered movement

between profiles of substance misuse across development. To accomplish this, LPA analyses from adolescence, emerging adulthood, and young adulthood were modeled together in a single LMM. LMMs are autoregressive models that quantify change in latent profile membership across time. These techniques use individual most likely profile membership to uncover the individual propensity to shift between profiles (or remain stable) across time (Lanza et al., 2012). Two types of LMMs were tested, a latent transition analysis (LTA) and a repeated-measures LPA (RMLPA). Both LTA and RM-LPA were tested to identify the best model for the underlying data. LTA and RM-LPA are similar techniques; however, LTA requires measurement invariance and transition invariance (Ryoo et al., 2018).

Measurement invariance across time results in indicator variables giving way to the same latent profiles at each timepoint (i.e., the meaning of latent profiles is stable across time). Transition invariance specifies that movement probabilities between timepoints are equal (e.g., transitions from adolescences to emerging adulthood and transitions from emerging adulthood to young adulthood had similar transition and stability probabilities). Removing either of these constraints transforms an LTA to a RM-LPA. In a RM-LPA, the meaning of the profiles can differ between timepoints and movement patterns, stability and transition probabilities can be freely estimated at each timepoint. The constraints of measurement invariance and transition invariance were tested to select the best model for the underlying data. The final model selected from this exploration of the data provided the behavioral transition and stability patterns in substance misuse.

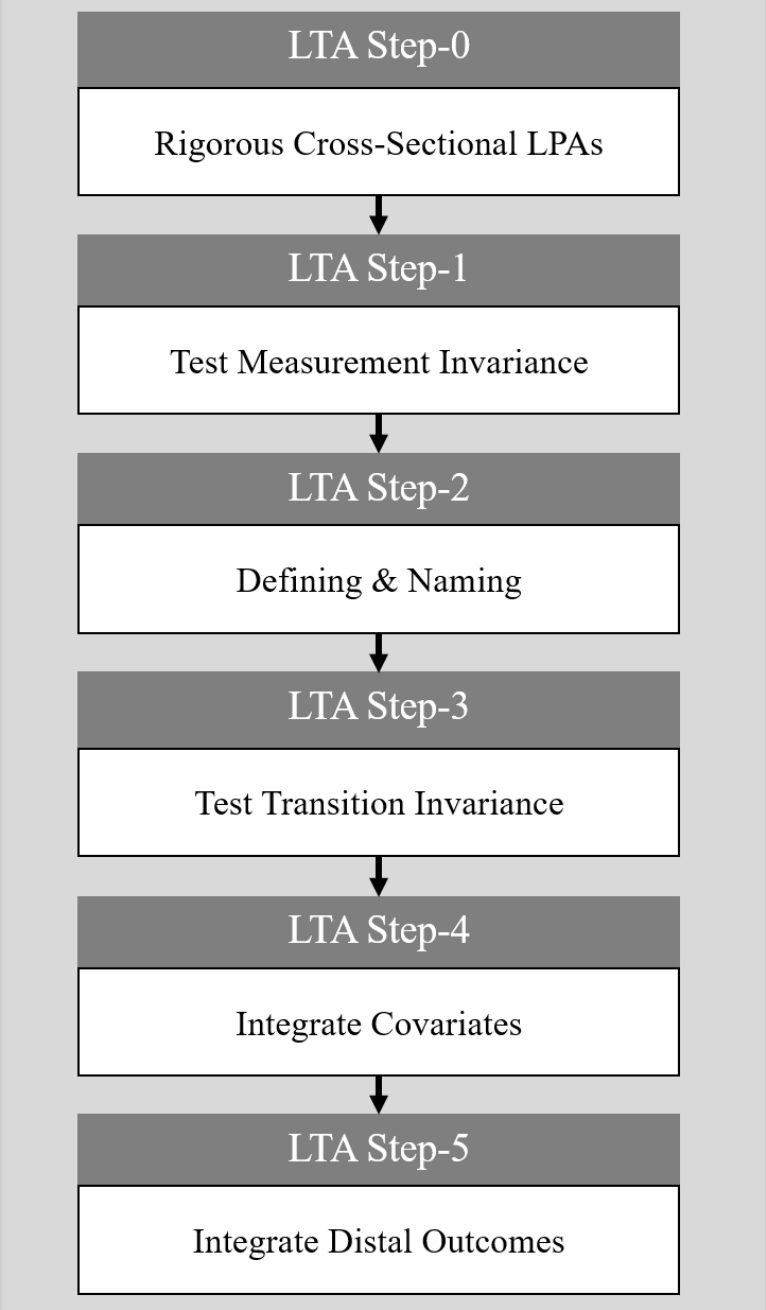
Standards for evaluating LMMs with absolute fit indices are not well-defined. Absolute model fit indices assess whether an LMM model adequately represents the underlying data without referencing a competing LMM model (Ryoo et al., 2018). Absolute model fit indices appropriate for cross-sectional mixture models, like BLRT, have not yet been studied for longitudinal mixture models. The likelihood-ratio statistic, G2, has been recommended for LTA; however, the likelihood-ratio G2 is only applicable to ordinal and binary latent variable indicators, which were not used in this dissertation. Even when ordinal and binary latent variable indicators are used in latent class formation, G2 is sensitive to sparse cells that often exit in LMMs. These limitations on available absolute fit statistics make evaluating LMMs less prescriptive. This dissertation followed steps 0 through 5 of the LTA 5-step approach established by Ryoo et al. for building sound latent transition analyses using relative model fit indices (Figure 3.4). The syntax for the final LMM can be found in the Appendix D.

Step-0. The 5-step approach begins with LTA Step-0, rigorous exploration of cross-sectional data. LTA Step-0 aligns with the LPA 3-step approach described in the previous section. The product of LTA Step-0 is methodically and theoretically enumerated latent profile analyses at each timepoint.

Step-1. Step-1 of the LTA explores measurement invariance. Measurement invariance suggests that the items are endorsed at the same rate across timepoints. Where measurement invariance is achieved, the analysis would remain classified as LTA. Where measurement invariance is not achieved, the analysis would become classified as a RM-LPA. In LTA Step-1 several LTA Step-1 models were ultimately compared to identify

Figure 3.4

Flow Chart for the 5-Step Latent Transition Analysis (LTA) Approach



Note. LTA 5-step approach prescribed by Ryoo et al. (2018)

the best fitting measurement model for the data. Testing measurement structure began with running an LTA Step-1 model with full measurement invariance and then systematically reducing constraints to compare nested models. Systematic changes were made to the full measurement invariance LTA Step-1 model by testing theoretically sound intermediate measurement models. Finally, full measurement noninvariance, which allowed for the independent estimation of each indicator variable across time, was tested. All LTA Step-1 models were compared using log likelihood difference testing along with the AIC and BIC.

Step-2. LTA Step-2 is concerned with defining the latent statuses. Given the measurement variance structure obtained in LTA Step-1, the meaning of the structure was explored for substantive meaning. Names of the profiles were reconsidered for profiles across time. The product of LTA Step-2 was quantitatively and substantively defined measurement variance structure for the data.

Step-3. Once a measurement model was selected, LTA Step-3 tested transition probability variance structure. Two structures were tested—full-invariance and full-noninvariance. Full transition probability invariance constraints transitions to be equal across time between latent profiles.

Transition probability full variance allows free movement for participants across time and between profiles. Models were compared using the LRDT and by comparing AIC and BIC values. LTA Step-3 terminated with the selection of the best longitudinal mixture model that was reflective of the measurement and transition variance in the underlying data.

Step-4. LTA Step-0 through LTA Step3 provided a rigorous process for developing an LMM that was reflective of the underlying data. After the selection of the best LMM model, the analysis was prepared for the integration of covariates. Waiting to add covariates until the LMM model is constructed prevents covariates from unduly influencing latent processes at each step of model building (Nylund-Gibson & Choi, 2018). In LTA Step-4 covariates of gender, race, and childhood SES were added to the LMM model to provide context to the analysis as time invariant covariates. Covariates were interpreted for each LPA at this point.

Step-5. The final step of the 5-step process proposed by Ryoo et al. (2018) was the addition of distal outcomes. Distal outcomes were not incorporated at this point in the analysis; thus, Step-5 was not conducted.

Research Question 2

The goal of Research Question 2 was to explore the impact of maturing-out of risky substance misuse on adult self-sufficiency. While research suggests poorer health outcomes for substance misusers (McCambridge et al., 2011), it is less clear if substance misuse effects the psychosocial indicators of development, like self-sufficiency. Specifically, longitudinal patterns of substance misuse were used to differentially predict indicators of self-sufficiency in young adulthood.

Mover-Stayer Model

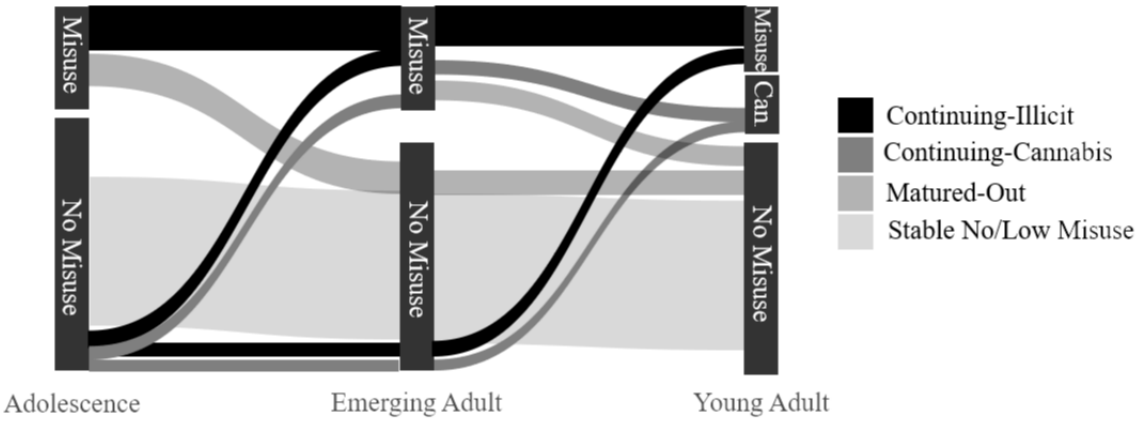
Latent Mover-Stayer (MS) models assume that there is underlying heterogeneity in individual transition probabilities across time (Goodman, 1961), such that, some

individuals are prone to "stay" or remain in a certain latent classification and others are prone to "move" or transition between latent classifications across time. Given that the transition to adulthood is a highly unstable period of development, substantial individual movement between substance misuse profiles across time were expected. The numerous types of transitions were condensed in a MS model to reflect important patterns of stability and movement. Of particular interest was the pattern that cumulates in maturing-out of misuse, a pattern that is regularly seen in epidemiological studies of substance misuse. To answer Research Question 2, "Does maturing out of substance misuse influence young adult self-sufficiency?" a second order, 3class latent variable was added to the LMM model used to address Research Question 1. First, a specialized "stayers" profile was created. In traditional MS models, stayers are any individuals who remain in the same profile across time (Nylund, 2007). In this analysis the stayer profile included only individuals who maintained no/low misuse across all developmental periods. Next, the first "movers" profile was defined as those who had patterns of misuse but Matured-Out by young adulthood. This mover profile encompassed various transitions sequences, but all transitions terminated with participants in the no/low misuse profile by young adulthood. Finally, a "movers and/or stayers" profile was created. This third profile captured transition patterns that terminated in continued misuse of substances. The MS model is visualized in Figure 3.5.

The MS model was created by adding a secondary latent model to the LMM model. The secondary latent model separated participants by applying model constraints to the transition probabilities (L. K. Muthén & Muthén, 1998-2017, pp. 225-227). The

Figure 3.5

Theoretical Transitions Between Substance Misuse Across Development for Conceptualizing Research Question 2



expected substance use pattern for these individuals would be no/low misuse in adolescence, no/low misuse in emerging adulthood, and no/low misuse in young adulthood. Model constraints for the Matured-Out profile allow movement between adolescence and young adulthood and then constrain participants to terminate in the no/low misuse profile by young adulthood. Participants in the continued-use profile were permitted to move between adolescence and emerging adulthood and then constrained to terminate in a profile defined by substance misuse in young adulthood.

Two methods for applying MS model constraints were explored to answer Research Question 2, (1) the probability parameterization and (2) the logit parameterization. The probability parameterization is a more user-friendly method for forming the mover-stayer latent variable. This parameterization utilized the transition probabilities from the LMM output. This technique allows for cleaner classifications. The downside of this method is that covariates and distal outcomes are not permitted in the

MS model (L. K. Muthén & Muthén, 1998-2017, p. 227). To test covariates or distal outcomes, mover-stayer classification must be hard-coded. When classifications are hard coded for extended analysis, model error is ignored resulting in biased models. Hard-coding latent variables has been shown to be problematic and is considered a practice that should be avoided; however, when model entropy is high the practice is less impactful on the estimated model (Clark & Muthén, 2009).

The second method for estimating the MS model utilizes logit parameterization in Mplus. This parameterization allows for the incorporation of covariates and distal outcomes that is not permitted in the probability parameterization. This method is superior to hard-coding outcomes because it continues to account for model error in latent modeling and produced less biased estimates (Asparouhov & Muthén, 2019). The challenge with the logit parameterization stems from the nature of logits asymptotes. This can make the classification less precise than the probability parameterization with complexed models (L. K. Muthén & Muthén, n.d.). Clear instructions for using the probability or logit parameterizations in longitudinal models with more than two timepoints, continuous indicator variables, and complexed mover-stayer schemes are not currently developed.

Finding that the methods for complexed MS models were underdeveloped, this dissertation undertook the major task of expanding the principles outlined for simpler models to accomplish the analyses included in the current project. The development of methods for estimating complexed MS models with more than two timepoints, continuous indicators, and complexed MS schemes adds meaningfully to the current

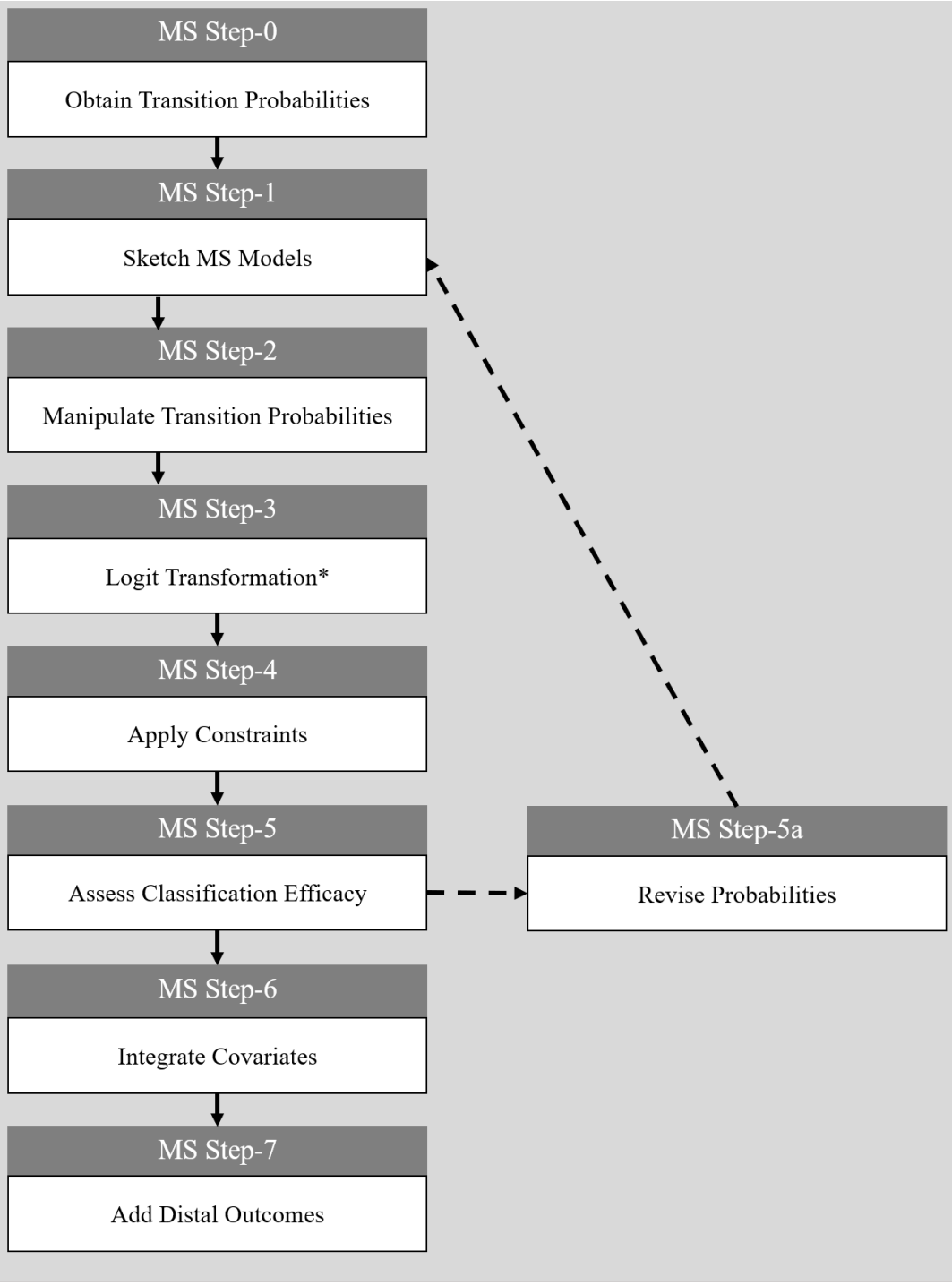
quantitative psychology literature. The process outlined in detail in this dissertation, along with Mplus syntax found in the appendices, will facilitate research using MS models. The methods outlined here can transcend disciplines for the benefit of the scientific community.

Both the probability and logit parameterizations are relatively straightforward when two timepoints are considered or the classifications schemas are simple (LTA with Movers-Stayers). However, when more than two timepoints are examined and the mover-stayer classification schemas are complicated model building requires finessing in addition to the currently established model guidelines. The methods and art for constraining an MS model with three or more timepoints with complicated classifications is described in the section below. Figure 3.6 shows a flow chart for estimating an MS model with three or more timepoints, continuous variables, and complicated mover-stayer schemes.

Step-0: Obtain transition probabilities. Obtaining the transition probabilities between timepoints is the fundamental step in estimating an MS model. The LTA 5-steps outlined by Ryoo et al. (2018) provide a rigorous process to obtain a satisfactory LMM that reflects the underlying data. The transition probabilities tables can be obtained from the LMM analysis Mplus output. The tables, labeled “latent transition probabilities based on the estimated model,” provide the T1 profiles along the rows and the T2 profiles along the columns. The number reflect the probability of transitioning between a give T1 profile to a T1 profile. The second table contains the T2 profiles on the rows and the T3 profiles along the columns. Where four timepoints exist, there would be a third table, etc.

Figure 3.6

Flow Chart for the 7-Step Mover-Stayer (MS) Model Estimation Process for Complex MS Models



Step-1: Sketch MS Models. The first step in estimating a complicated MS model is to sketch the desired matrices across all timepoints for each mover-stayer profile. This is done by creating empty matrices (see Table 3.7 for an example), where the rows represent the Tx LCA profiles (P1, P2, P3) and the columns represent the Tx+1 LCA with the same P1 through P3 profiles.

Table 3.7

Mover-Stayer (MS) Step-1: Empty Transition Matrices for a Three Timepoint MS Model Sketch

		T_2				T_3		
		P1	P2	P3		P1	P2	P3
T_1	P1				T_2 P1			
	P2				P2			
	P3				P3			

To clearly explain the MS model estimation process, an example will be used. Table 3.8 displays the theoretical MS model for the example. The first theoretical MS profile of the second-order, mover-stayer latent variable model is a mover profile interested in participants who terminate in P2, but that are not stayers in P2 across all timepoints (i.e., this is a mover-specific profile), this profile will be called the Mover Terminal P2 profile. The second MS profile is a stayer profile, where individuals remain in the same profile across all timepoints, this profile will be referred to as the Stayer profile. The final MS profile will be the All Other Participants profile.

Consider the sketch for the Mover Terminal P2 profile. There are several blank cells with no clear expectation for what must occur between Tx and Tx+1. Depending on

Table 3.8

Example Mover-Stayer (MS) Step-1: Sketched Transition Matrices for a Three Timepoint MS Model Sketch

(A) Mover terminal P2

		T_2					T_3	
	P1	P2	P3		P1	P2	P3
T_1 P1				T_2 P1	0	1	0
T_1 P2		0		T_2 P2	0	1	0
T_1 P3				T_2 P3	0	1	0

(B) Stayer class

		T_2					T_3	
	P1	P2	P3		P1	P2	P3
T_1 P1	1			T_2 P1	1		
T_1 P2		1		T_2 P2		1	
T_1 P3			1	T_2 P3			1

(C) All other movers

		T_2					T_3	
	P1	P2	P3		P1	P2	P3
T_1 P1				T_2 P1	0	0	
T_1 P2		0		T_2 P2		0	
T_1 P3				T_2 P3		0	0

the overall MS model, it is possible that the unspecified boxes could be estimated without applying specific constraints (i.e., the values could be chosen by Mplus within the MS model estimation). It is also possible, however, that constraints will need to be applied to optimize classification specificity. These estimates will be obtained from the transition probabilities generated during MS Step 0.

Step-2: Manipulate transition probabilities. To consolidate various transitions patterns to fewer theoretically relevant patterns, the transition probabilities tables

obtained from LMM should be used as a guide for applying transition constraints for complexed MS models. In cases where the transition probabilities obtained from the LMM reflect expected transitions across all timepoints, the values from the transition probabilities can be directly used in the MS model development. However, in complexed models there is a likelihood that the specific transition probabilities will merely act as a guide for estimating constraints. In this case, where the transition probabilities act as a guide, it is necessary to methodically manipulate the transition probabilities to reflect the expected transition probabilities for each mover-stayer profile.

Consider Table 3.9, which displays transition probabilities. Note that all rows sum to 1 at each timepoint, as would be expected with probabilities. The probability of being stable in P1 between T1 and T2 is 50%. The probability of being stable in P1 between T2 and T3 is also 50%. In other words, 50% of the P1 profile at T1 stay in P1 at T2, and then 50% of P1 at T2 stay in P1 at T3 (see the blue boxes in Table 3.9). The yellow boxes show a transition pattern, 10% of P1 at T1 transition to P2 by T2. Between T2 and T3 45% stay a P2, while 25% return to a P1 and 30% change to a P3. The table can be interpreted in this manner for all 27 possible patterns.

Table 3.9

Example Mover-Stayer (MS) Step-0: Longitudinal Mixture Model (LMM) Transition Matrices for a Three Timepoint Model

		T_2		
		P1	P2	P3
T_1	P1	.50	.10	.40
	P2	.25	.45	.30
	P3	.20	.20	.60

		T_3		
		P1	P2	P3
T_2	P1	.50	.10	.40
	P2	.25	.45	.30
	P3	.20	.20	.60

To use the transition matrix obtained from Step-0 as a guide (Table 3.9, the mover-stayer sketch and the actual transition matrix should be merged with blank cells as seen in Table 3.10. After merging the transition matrix probabilities with the sketched matrices for the mover-stayer profile it becomes clear that some rows no longer sum to 1 as they should (see Figure 3.10).

Table 3.10

Example Mover-Stayer (MS) Step-1: Merged Longitudinal Mixture Model (LMM) Transition Matrices with Sketched Transition Matrices for a Three Timepoint MS Model

(A) Mover terminal P2

		T_2					T_3			
		P1	P2	P3			P1	P2	P3	
T_1	P1	.50	.10	.40	= 1.00	T_2 P1	0	1	0	= 1.00
	P2	.25	0	.30	= 0.55	P2	0	1	0	= 1.00
	P3	.20	.20	.60	= 1.00	P3	0	1	0	= 1.00

(B) Stayer class

		T_2					T_3			
		P1	P2	P3			P1	P2	P3	
T_1	P1	1	0	0	= 1.00	T_2 P1	1	0	0	= 1.00
	P2	0	1	0	= 1.00	P2	0	1	0	= 1.00
	P3	0	0	1	= 1.00	P3	0	0	1	= 1.00

(C) All other movers

		T_2					T_3			
		P1	P2	P3			P1	P2	P3	
T_1	P1	.50	.10	.40	= 1.00	T_2 P1	0	0	.40	= 0.40
	P2	.25	0	.30	= 0.55	P2	.25	0	.30	= 0.55
	P3	.20	.20	.60	= 1.00	P3	.20	0	0	= 0.20

Where the transition matrices rows do not sum to be 1, the cell values must be

adjusted to do so. To accomplish this, divide the transition probability by the sum of the row. In the mover profile which terminates in P2, the matrix between T1 and T2 has one row that no longer equals 1, instead it sums to 0.55. The first cell (0.25) and last cell (0.30) of this row are divided by the row total (0.55) to prorate the row to equal 1. The new values for that row become 0.455, 0, and 0.545. This is done for each row where the sum does not equal 1.

Step-3: Logit transformation. MS Step-3 is only necessary when covariates or distal outcomes will be integrated into the MS model. If using the probability parameterization, the probabilities from MS Step-2 can be used directly in the MS model estimation as constraints to form the mover-stayer profiles. In cases where covariates and/or distal outcomes are important to the research question, MS Step-3 is necessary as it transforms the probabilities to logits. Once the researcher has filled in the hypothetical transition matrices with the adjusted transition probabilities from MS Step-2 so that all rows equal 1, the probabilities are ready to be transformed to logits. The formula for this transition is below.

$$\text{(i) } \text{Log}(Pa/Pb) = \text{logit}$$

Pa is the probability of the first cell in the first row and Pb the reference cell in the first row (usually the last profile). Note that the order of profiles may be significant, in these cases, researchers may need to reorder profiles so that the reference class make theoretical or analytic sense. In beginning the transformation, it is also necessary to recall two properties of the number 0; any number divided by 0 is undefined and the log 0 is undefined. Where the reference cell (Pb) is equal to 0 or where the solution of Pa/Pb

would equal 0, the 0 value should be adjusted to 0.000001. As an example, **Table 3.11** illustrates the transition for the All Other Movers profile between Tx and Tx+1. P3 is used as the reference for each row. Once all probabilities are transformed, the logits are then applied to the LMM model as constraints to form the MS model.

Table 3.11

Example Mover-Stayer (MS) Step-3: Logit Transformation of Manipulated Transition Matrices (from MS step-2) for the "All Other Movers" between T1 to T2

		T_2 probabilities				T_2 logits	
		P1	P2			P2	P3
T_1	P1	Log(0.50/0.40)	Log(0.10/0.40)	T_2	P1	0.097	-0.602
	P2	Log(0.40/0.55)	Log(0.00001/0.55)		P2	-0.097	-4.740
	P3	Log(0.20/0.60)	Log(0.20/0.60)		P3	-0.477	-0.477

Step-4: Apply constraints. MS Step-4 for estimating complexed MS models is to apply the constraints to the LMM model. If the probability parameterization is used, the probabilities established in MS Step-2 will be used to specify the MS model. When the logit parameterization is used, the transformed logits from MS Step-3 are applied to the MS model syntax. For the All Other Participants profile defined in this hypothetical example, the code would be as follows.

```
%M#3% !All Other Movers
T2#1 on T1#1@0.097; !logits of the event probability obtained in Step 3
T2#2 on T1#1@-0.602;

T2#1 on T1#2@-0.097;
T2#2 on T1#2@-4.740;
```

The last profile is not mentioned in Mplus syntax by design, that means the P3

row is not directly specified in the code.

The constraints placed upon the LMM model will condense the various transition patterns into the theoretically relevant patterns. It should be noted that for simpler MS models, methods have been outlined by L. K. Muthén and Muthén (n.d.) in the Frequently Asked Questions on "LTA with Mover-Stayers" page, which states, "the probabilities of 1 and 0 correspond to +Large and -Large logit values" (paragraph 7). However, for more complicated mover-stayer analyses (models that contain more than two timepoints, have continuous outcomes, or have delicate separation parameters, like the one presented in this paper) the steps outlined here were vital to clearly distinguish the mover-stayer classifications.

Step-5: Assess Classification Efficacy. After running the analysis with the logit constraints, the MS model classification accuracy must be assessed in MS Step-5. This is done using the "Final class Counts and Proportions for the latent Class Patterns Based on Estimated Posterior Probabilities." The MS model constraints applied to the data should separate the patterns into the appropriate mover-stayer profiles. Where extensive or systematic misclassifications are seen, the MS model constraints should be revisited in MS Step-5a to enhance classification accuracy where possible. This is done by returning to MS Step-1 and to perform further systematic changes to improve the MS model classification.

For example, consider the mover class Mover Terminal P2 and the Stayer profile from this example. Both matrices have the transition between T2 and T3 for the P2 profile equal to 1. The transition probability in the first tested model would have the same

constraint for this transition for both the mover-stayer profiles. Upon consideration of the estimated model in MS Step-5, a large portion of P2 stayers may appear in the mover class that terminates in P2. In this case, an adjustment to the probabilities would be merited to enhance the separation between these two profiles. The way adjustments are made will be guided by what was provided by the transition probability matrix from and the LMM model that those constraints produced.

While it is permitted to enhance the MS model to elevate systematic misclassifications, some degree of misclassification is expected. As explained by L. K. Muthén and Muthén (n.d.) in the Frequently Asked Questions on "LTA Mover-Stayer – Why Some Movers are Staying," some misclassification occurs because "observed variable values are on the whole more similar" to an unanticipated classification. This misclassification is a strength of participant-centered models and not a weakness. Instead of hard classifying based on most likely latent class membership, participants who have a more ambiguous profile may ultimately be better characterized by membership in an unanticipated mover-stayer class than would be seen if only hard classifications were considered. L. K. Muthén and Muthén continued, "perhaps such results are more common with continuous outcomes than with categorial ones."

Where multiple models are tested in MS Step-5, the BIC, AIC, and entropy values should be considered in selecting the best model for the data. Currently, specific model comparison tests have not been optimized for MS models. Without recommended model comparison fit statistics, the way models are estimated should follow a methodological process. The established flow for estimating complexed MS models provides a first step

in model specifications and should be built on to better define fit statistics appropriate for MS models.

Steps 6 and 7: Include Covariates and Distal Outcomes. Similar to the LPA 3-step approach for cross-sectional mixture modeling and the LTA 5-step approach for LLM modeling, the final steps in building a MS model are incorporating covariates and distal outcomes into the MS model. The addition of distal outcomes is the target for Research Questions 2 and 3 and the addition of predictor variables is the target of Research Question 4.

Predicting Self-Sufficiency from Mover-Stayer Classification

To estimate the impact of maturing-out of substance misuse on self-sufficiency, the means of the distal outcomes (young adult autonomy, personal responsibility, and financial independence) were compared between the three mover-stayer profiles by fitting two sets of constraints. The MS model was first constrained the distal outcome to be equivalent to the grand mean for all MS profiles. Next, the MS model freely estimated the distal outcome means for each MS profile. The competing versions of the MS model were compared using log likelihood difference testing along with the AIC and BIC.

Where free estimation of distal means better fitted the data, post-hoc comparison of profile means was conducted to identify which means varied from the mean of the Stable Normative profile. Post-hoc comparisons used a *z* test and Hedge's g to estimate the effect size for normally distributed outcomes. Hedge's g was the most appropriate effect size choice as it used pooled, weighted variance which allowed the sample sizes

and variances to differ between profiles. Hedge's g is also less biased in the face of non-normally distributed variables which are possible in the current study (Marfo & Okyere, 2019). Since the post-hoc comparisons of means increased the chances of type I error, the alpha level for all mean comparisons were reduced to 0.01 using the two-tailed z-distribution with a critical value of z01 = 2.33. For skewed data, a Wilcoxon-Mann-Whitney ranked sums test was conduct and used the Wilcoxon's r as a measure of effect size, again adjusting the significance level to account for multiple post-hoc analyses to a $p \leq .01$. Finally, for Poisson distributed data, a Poisson process evaluation was used. The rate ratio was calculated to provide an estimate of the effect size, using the Stable Normative profile as the reference.

Research Question 3

The goal of Research Question 3 considered a contemporary trend in substance misuse policy. Over the past decade, policy change has legalized medical and recreational cannabis in many regions of the U.S. The debates surrounding the legalization processes have also shifted perceived risk and have increased availability. Yet, research is still emergent regarding the long-term physical, cognitive, and social impacts of cannabis use. This dissertation provided an opportunity to investigate the association between regular cannabis use and young adult self-sufficiency.

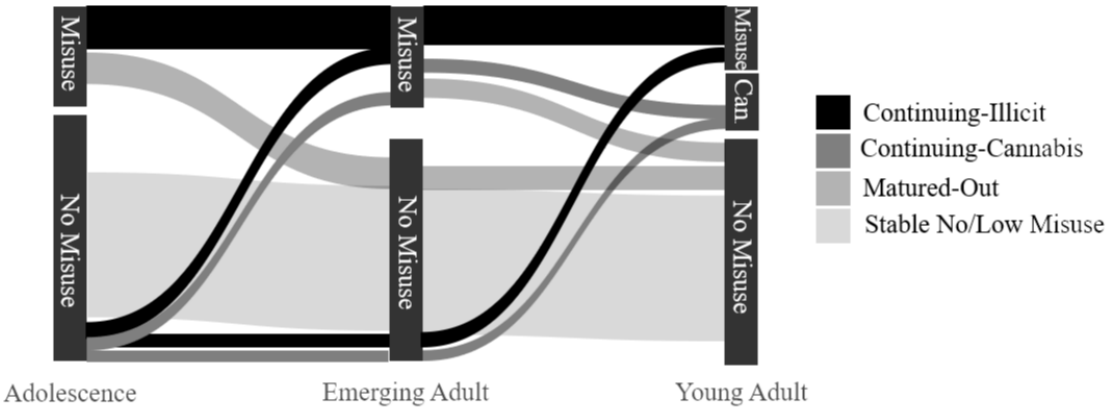
Mover-Stayer Model for Cannabis Users

Building on the methods from Research Question 2, the MS model was further constrained to isolate participants who were cannabis-only consumers at the final

timepoint in young adulthood. This created an additional mover/stayer profile that stratifies the continuing-user profile in Research Question 2, which included all participants that had any substance misuse during young adulthood. For Research Question 3, the portion of Continuing Users who were Continuing-Cannabis users by young adulthood became their own profile, the other users became Continuing-Illicit users. The MS model selection process followed the steps outlined in Research Question 2 and can be visualized using Figure 3.7.

Figure 3.7

Theoretical Transitions Between Substance Misuse Across Development for Conceptualizing Research Question 3



Predicting Self-Sufficiency from Mover-Stayer Classification

Similar to Research Question 2, the same analytic procedures were followed for evaluating the distal outcomes with four MS profiles instead of three MS profiles.

Research Question 4

It is important to understand predictors of maturing-out of substance misuse. Substance misuse is viewed in many incongruent ways; as a major public health concern, a disease, a developmentally isolated risk behavior, and a rite of passage (Crawford & Novak, 2006; Parker et al., 2002; Shedler & Block, 1990). Regardless of the viewpoint on substance misuse, there are practical benefits to being able to distinguish between those who are likely to mature out and those who are likely to continue using into young adulthood.

To understand predictors of mover-stayer substance use classification, a multinomial regression was incorporated into the MS model estimation exploring the association between educational attainment, event-based development (homeownership, marriage, and parenthood), and self-perceived adult status on mover-stayer classification. The MS profile defined by no/low substance misuse was used at the reference profile.

Software

Data manipulation in preparation for model building was completed with R 4.0.2 (R Core Team, 2020). All subsequent modeling was carried out using Mplus V8.0 (L. K. Muthén & Muthén, 1998-2017). Full model codes for the LPA, LMM, and MS models are included in the Appendices.

Missing Data

As expected with any longitudinal study, attrition existed in the Add Health data. Retention rates at the fourth wave of data collection were 80.3%. Past research on Add Health found data to be missing at random. Harris et al. (2010) investigated attrition

based on earlier substance misuse behaviors. This study found a nonsignificant association between earlier substance misuse and attrition at wave IV.

This project utilized two analytical techniques to account for missingness. The first technique handled missingness as it relates to the national representativeness of the sample. The second is to maximize available information. First, Add Health administration suggested that appropriate weights be applied to the data to make the sample nationally representative and account for missingness at the final survey occasion. Second, to maximize the available data across time, this project utilized full information maximum likelihood (FIML) estimation. This technique is the preferred way to deal with data that are missing at random (B. O. Muthén & Shedden, 1999). Mplus seamlessly incorporates the provided survey weights and applies FIML, see the Appendices for code.

CHAPTER 4

RESULTS

Research Question 1

Latent Profile Analyses

The enumeration process for each developmental period produced three cross-sectional LPA models for comparison before the data reached non-convergence. Quantitatively, the 3-profile model was an improvement on the 2-profile model and the 4-profile model was an improvement on the 3-profile model; results in Table 4.1. The following section explores the enumerated classes at each developmental period by describing the process through which a final model for each stage was selected.

LPA for Adolescence

In adolescence, the LPA model fit indices suggested the 4-profile model was preferable to the other models tested, the syntax for the final model can be found in Appendix A. The 4-profile model was compared to the 3-profile model to explore the parsimony and theoretical relevance of the LPA models generated for substance misuse during adolescence, Figure 4.1. The 3- and 4-profile models both contained a large no-to-low misuse pattern of comparable proportions, 92.00%. The 3- and profile model both contained a small polysubstance use pattern of comparable proportions, 1.34%. The difference between the LPA models stemmed from splitting the third profile observed in the 3-profile model. In the 3-profile model, the final profile reflected a low-poly substance use pattern. Individuals in this profile, used alcohol heavily about once a

Table 4.1

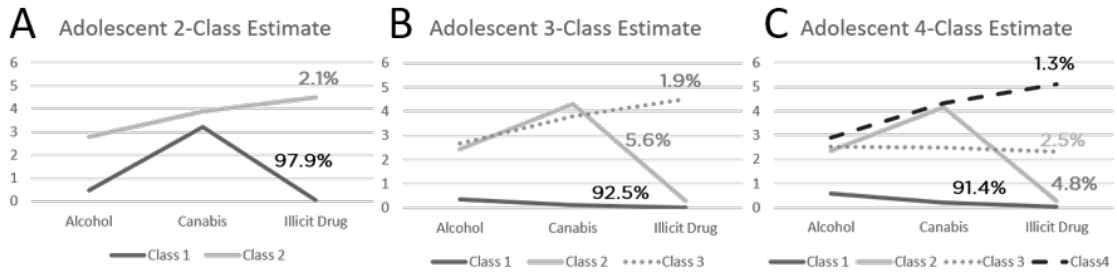
Model Fit Indices for Latent Profile Analyses (LPA) Class Enumeration Process

					LRT *p* value	
Classes	Free parameters	LL	BIC	LMR-LRT	LMR	Bootstrap
Adolescence						
2	10	-49177.0	98450.3	27517.3	< .001	< .001
3	14	-40353.3	80841.5	17201.2	< .001	< .001
4	**18**	**-33149.2**	**66471.8**	**14043.9**	**< .001**	**< .001**
5				Did not converge		
Emerging adulthood						
2	10	-67132.7	134285.3	23579.8	< .001	< .001
3	14	-59367.2	118870.5	15141.0	< .001	< .001
4	**18**	**-51915.3**	**103405.7**	**14530.4**	**< .001**	**< .001**
5				Did not converge		
Young adulthood						
2	10	-60192.5	120481.6	27827.7	<.001	<.001
3	14	-51466.5	103068.3	17011.6	<.001	<.001
4	18	-45268.4	90710.8	12083.4	<.001	<.001
5	**22**	**-40869.6**	**81951.7**	**8575.8**	**<.001**	**<.001**
6				Did not converge		

Note. Bolded text reflects the selected model. LL = log likelihood; BIC = Bayesian Information Criterion; LMR = Lo-Mendell-Rubin; LRT = Likelihood Ratio Test.

Figure 4.1

Latent Profile Analyses (LPA) Across Tested Enumerations for Adolescence



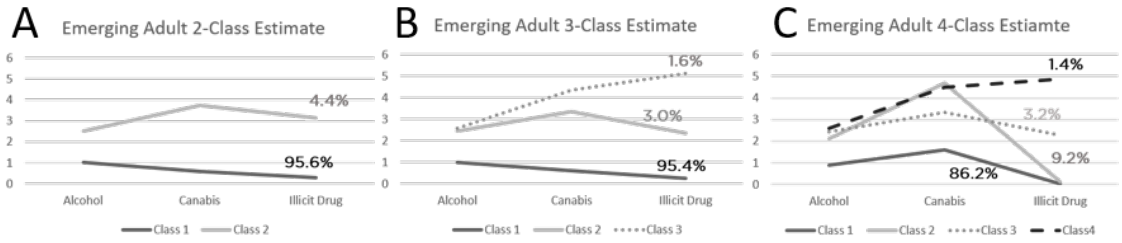
month, consumed cannabis about once a month, and used illicit drugs less than monthly (see the medium gray line in Figure 4.1B). In the 4-profile model the low polysubstance use profile was split into a low polysubstance use pattern and a low alcohol-cannabis pattern (Figure 4.1C). The low alcohol-cannabis pattern was similar to the low-poly substance use pattern with a lower level of illicit drug use. The substantive meaning between level of illicit drug use reflects a behavior divergence in the profiles. Individuals in the low polysubstance use profile use illicit drugs on average between "2 or 3 times a month" and "1 or 2 times a week." Individuals in the alcohol-cannabis profile use illicit drugs once a month or less. Given the substantive mean between the separation of profiles the 4-profile model was selected as the best fit for the data.

LPA for Emerging Adulthood

A visual comparison of LPA models between two and four profiles can be seen in Figure 4.2. In emerging adulthood, the quantitative statistics indicated that the 4-profile model was the best fitting model tested. The substantive meaning of the 3and 4-profile models were explored. The 3-profile model, Figure 4.2B, contained a large no-to-low misuse pattern with ¬87.01% of the sample in this profile, a cannabis-use profile with 11.71% of the sample following in this profile, and a polysubstance use profile with 2.56% of the sample. The 4-profile model, Figure 4.2C, contained a similar and large no-to-low misuse pattern, the remaining three profiles exhibited different levels of polysubstance use. Each of these profiles has a similar level of alcohol misuse, ranging between means of 2.57 and 3.01. The substantive meaning describes alcohol use as being between "once a month" and "2 or 3 times a month." The profiles differ on their level of

Figure 4.2

Latent Profile Analyses (LPA) Across Tested Enumerations for Emerging Adulthood



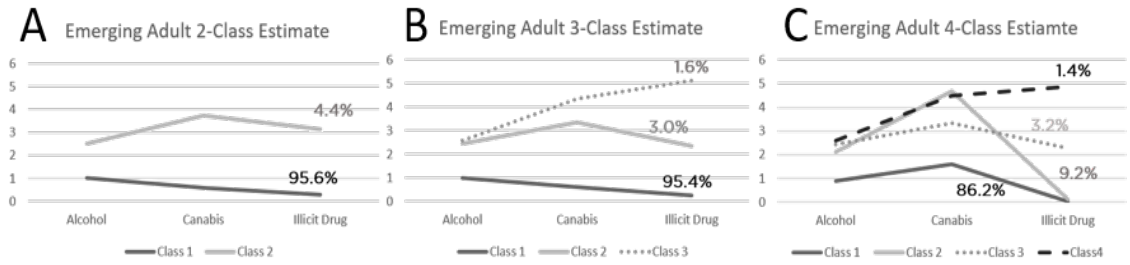
cannabis and illicit drug use. The highest using profile used cannabis between "3 to 5 days a week" and "every day" and illicit "every day." This profile was named the high polysubstance use profile. The second and third polysubstance use profiles used cannabis more than illicit drugs. The second highest using profile used cannabis between "1 or 2 times a week" and "3 to 5 days a week" and illicit substances between "2 or 3 times a month" and "1 or 2 times a week." While this profile uses less their patterns of misuse are still substantial, this profile was named the moderate polysubstance users. The final polysubstance use profile used cannabis between "2 or 3 times a month" to "1 or 2 times a week" and used illicit substances "once a month or less." Given the substantive difference between the 3and 4-profile models, the 4-profile model was selected as the best fit to the data.

Latent Profile Analyses for Young Adulthood

The profile enumeration process compared models with between two and five profiles, illustrated in Figure 4.3. The fit statistics in the enumeration process indicated that the 5-profile model during young adulthood was the preferable model. The 4- and 5-profile models were explored for their substantive meaning. The 4-profile model included

Figure 4.3

Latent Profile Analyses (LPA) Across Tested Enumerations for Young Adulthood



a large no-to-low misuse profile across all substances (87.4%). The second largest profile was distinguished by high cannabis use. This profile accounted for 8.4% of the sample. The sample mean for cannabis use was 5.2, reflecting daily cannabis use. The remaining two profiles were polysubstance use profiles—a high-illicit profile (2.1%) and a moderate polysubstance use profile (2.1%). Both profiles used alcohol and cannabis similarly; they engaged in monthly heavy alcohol use and used cannabis a few times a month. The high-illicit profile used an illicit substance "every day or almost every day." The moderate polysubstance use profile used illicit substances "2 or 3 times a month." In the 5-profile model the additional profile was similar to the high-illicit and moderate polysubstance use profiles from the 4-profile model. This profile was distinguished by an intermediate level of illicit substance misuse between the high-illicit and moderate polysubstance use profiles.

Given that the new profile identified in the 5-profile model was not markedly different from the high-illicit and the moderate polysubstance use profiles from the 4-profile model, the 4-profile model was chosen for its parsimony.

Selected Models

At each timepoint a 4-profile model best reflected the underlying data (see Figure 4.4. The meaning of the 4-profiles remained relatively similar (see Table 4.2. At each developmental period there was a large no-to-low misuse profile, this profile was referred to as the normative profile. At each timepoint, the normative profile was substantially larger than all other misuse profiles identified. At each timepoint there was a profile that misuse alcohol and cannabis but had low levels of illicit use. This profile was referred to as the alcohol & cannabis profile, this profile account for 4.2% to 8.4% of the sample. The third profile used alcohol, cannabis, and illicit substances moderately. This profile accounted for 2.2% to 3.9% of the sample across the developmental periods. Given the moderate level of use across multiple substances, this use pattern was referred to as the moderate polysubstance used profile. The final, and smallest, profile identified at each timepoint were those who endorsed misusing alcohol, marijuana, and illicit drugs. This profile was referred to as the high polysubstance profile and accounted for 1.3% to 2.1% of the sample. Means for the best model are shown in Table 4.2.

Figure 4.4

Selected Latent Profile Analyses (LPA) for Adolescence, Emerging Adulthood, and Young Adulthood

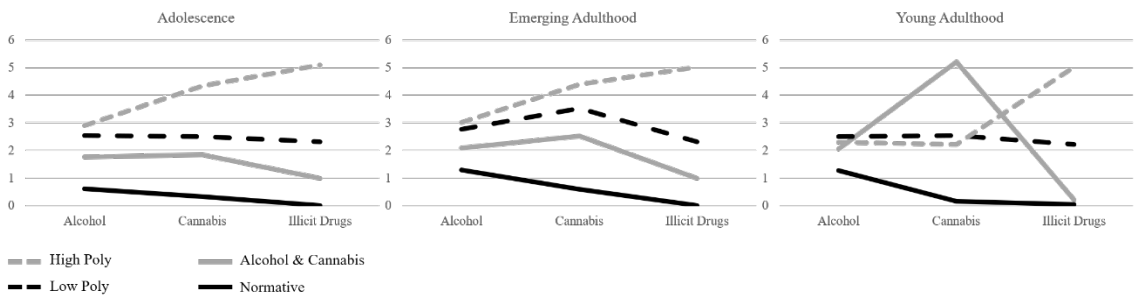


Table 4.2

Indicator Variable Means Within Each Latent Profile Across Adolescence, Emerging Adult, and Young Adult Developmental Periods

	Developmental period					
	Adolescence		Emerging adult		Young adult	
Latent profiles	%	Mean	%	Mean	%	Mean
Normative	95.0		86.5		84.4	
Heavy alcohol		0.606		1.286		1.269
Cannabis		0.340		0.590		0.155
Illicit drug		0.013		0.000		0.043
Alcohol and cannabis	4.2		8.0		8.4	
Heavy alcohol		1.765		2.095		2.046
Cannabis		1.847		2.515		5.204
Illicit drug		1.000		1.000		0.224
Low-poly substance	2.5		3.9		2.2	
Heavy alcohol		2.545		2.773		2.514
Cannabis		2.507		3.535		2.542
Illicit drug		2.316		2.322		2.221
High-poly substance	1.3		1.7		2.1	
Heavy alcohol		2.899		3.006		2.290
Cannabis		4.330		4.392		2.222
Illicit drug		5.103		5.014		5.018

In preparation for incorporating the three separate cross-sectional LPAs into a single LMM, the individual LPAs were transformed using the 3-step approach. First, the LPA's were ordered to structure some conformity between developmental stages, an example of the syntax used to order the LPAs can be seen in Appendix B. Once the LPAs were ordered similarly, the LPA models were corrected for bias using the LPA 3-step approach which hardcoded participant classification while accounting for model bias, the syntax for this can be seen in Appendix C. Once the LPA 3-step transformation was verified, the LPAs were prepared for the extended analyses that followed.

Longitudinal Mixture Model

To explore how participants transitioned between substance use profiles across time, a longitudinal mixture model analysis was conducted. The analysis followed the steps outline by Ryoo et al. (2018). Before settling on a final model measurement variance structure was explored, latent statuses stability was investigated, and transition probability variance structures were tested.

Step-1

Measurement variance structure. Longitudinal measurement variance structure refers how indicators are endorsed across time. Where indicators are endorsed consistently across time, latent statuses preserve their characteristics and meaning at each timepoint. Where indicator endorsement changes across time, the latent variables do not hold a consistent meaning across time. Latent transitional analyses have latent classes that hold their meaning across time (i.e., they are characterized by measurement invariance). When partial- or full-measurement invariance are not achieved, the analysis becomes a repeated-measures latent profile analysis. The function of these models is similar, to measure transition across time, but the model structure and the interpretation differ. To explore measurement invariance, first full measurement invariance was tested. Next, three partial measurement invariance structures were conducted by systematically allowing profiles to have different meanings across time. The systematic selection of which profiles were freed from the constraint of measurement invariance were chosen by cross-sectional comparison of LPA results. First, there were clear differences in the high polysubstance misuse profile across time. Specifically, in young adulthood, this profile

was no longer characterized by cannabis use. This profile could have measurement invariance across time. The second partial measurement invariance structure allowed the alcohol and cannabis profile to vary across time. This was selected because the pattern of use appears to change as this profile is characterized by high measurement cannabis use in young adulthood, but moderate use during adolescence and emerging adulthood. The third partial structure also reduced the constrain of measurement invariance for the low polysubstance use profile across time. Finally, full measurement noninvariance was tested for the LMM model (Table 4.3).

Table 4.3

Model Variance Structure for the Longitudinal Mixture Model (LMM) for LMM Step-1 Comparing LMM Measurement Invariance Structure

Model	LL	SC	AIC	BIC	*df*	cd	TR_{cd}	p-value
Full invariance	-151377.542	3.8426	302851.09	303232.19	48			
Partial 1	-151617.919	3.5581	303339.87	303752.71	52	0.14	-3336.25	< .001
Partial 2	-156409.150	3.6592	312934.30	313394.81	58	4.53	-2112.81	< .001
Partial 3	-156120.131	3.9166	312368.26	312876.41	64	6.40	90.25	< .001
Full noninvariance	**-154307.707**	**3.6605**	**308755.41**	**309311.20**	**70**	**0.93**	**3902.86**	**< .001**

Note. Bolded text reflects the selected model. LL = log likelihood; SC = Scaling Correction; AIC = Akaike information criterion; BIC = Bayesian information criterion; cd = $(d f_0 \times sc_0 - d f_1 \times sc_1)/(d f_0 - d f_1)$; $TR_{cd} = -2 \times (L_0 - L_1)/cd$.

Step-2: Defined Latent Status

Model comparison for measurement structure reveals that full noninvariance best reflected the underlying data. Full measurement noninvariance indicated that each profile has a unique substantive meaning across time. While similarities in patterns across time existed, the endorsement of the indicator variables was different across time, necessitating a full noninvariance structure.

The normative pattern maintained the lowest amount of substance misuse at each timepoint. Yet, the changes in the endorsement of substance misuse variables were substantial enough across time to require that the profile not be help constant across time. The largest changes in the normative profile across time were increases in alcohol and cannabis use during emerging adulthood. The increased use of alcohol corresponds to "less than monthly" heavy alcohol consumption during both emerging and young adulthood. Cannabis use was highest for the normative profile during emerging adulthood and lowest during young adulthood; however, the highest point of use still corresponded to most individuals in this profile never using cannabis. Across all timepoints, the normative profile did not engage in illicit drug use.

The alcohol and cannabis profile underwent substantial changes between emerging adult and young adulthood. During adolescence and emerging adulthood, this profile appeared to misuse alcohol and cannabis monthly and illicit drugs less than monthly. However, during emerging adulthood there was a steep increase in the use of cannabis. While this profile across time prefers alcohol and cannabis at all timepoints, there drastic change seen in young adulthood may indicate that it was not a smooth continuation of a profile.

The low polysubstance profile appears to be more continuous than the alcohol and cannabis profile. There is an increase in the amount of cannabis used by individuals in this profile during emerging adulthood. The change in cannabis corresponds from moving from using 2 – 3 times a month to using cannabis weekly. The amount of heavy alcohol use and illicit drug use remains relatively constant across time with monthly misuse.

The high polysubstance profile had very similar patterns between adolescence and emerging adulthood. Participants in this profile misused alcohol weekly, used cannabis 2 or 3 times a week, and used illicit drugs 4 to 6 times a week during adolescence and emerging adulthood. By young adulthood however, this profile transitioned to more moderate misuse of alcohol and cannabis, but maintained high levels of illicit drug use, using 4 to 6 times a week. The major similarity in this profile across time was associated with the high illicit drug use at each timepoint. However, the drastic changes in this profile by young adulthood may indicate that it was not a smooth continuation of a profile.

In Step-1 of the longitudinal mixture model building, full measurement noninvariance was a preferred reflection of the underlying data. In Step-2, the profiles were considered for the substantive meaning across time. The outcome of this consideration highlighted that some profiles maintained a consistent meaning across time, while others did not. For the profiles that maintained a consistent meaning, the profiles were defined by the same label across time. These profiles were the normative and the low polysubstance use profiles. The profiles that changed meaning were called alcohol and cannabis and high polysubstance use profiles in adolescence and emerging adulthood. However, after consideration in of the profiles longitudinally in Step-2, these profiles were not found to be smooth continuations and were defined uniquely. In adolescence and young adulthood, the profiles maintained the previously specified names, alcohol & cannabis and high polysubstance. In young adulthood, the new names were the cannabis profile and the high illicit profile (Table 4.4).

Table 4.4

Indicator Variable Latent Means and Proportions in Longitudinal Mixture Model (LMM) for LMM Step-2 Defining and Naming Latent Profiles

	Developmental period					
	Adolescence		Emerging adult		Young adult	
Indicator variable	%	Mean	%	Mean	%	Mean
Normative	92.0		86.5		84.4	
Heavy alcohol		0.606		1.286		1.269
Cannabis		0.34		0.590		0.155
Illicit drug		0.013		0.000		0.043
Alcohol and cannabis	4.2		8.0		-	
Heavy alcohol		1.765		2.095		-
Cannabis		1.847		2.515		-
Illicit drug		1.000		1.000		-
Cannabis	-		-			8.4
Heavy alcohol		-		-		2.046
Cannabis		-		-		5.204
Illicit drug		-		-		0.224
Low-poly substance	2.5		3.9		2.2	
Heavy alcohol		2.545		2.773		2.514
Cannabis		2.507		3.535		2.542
Illicit drug		2.316		2.322		2.221
High-poly substance	1.3		1.7			
Heavy alcohol		2.899		3.006		
Cannabis		4.330		4.392		
Illicit drug		5.103		5.014		
High illicit					2.1	
Heavy alcohol						2.290
Cannabis						2.222
Illicit drug						5.018

- Denotes no applicable values.

Step-3: Latent Transition Variance Structure

After defining the variance structure and latent statuses, the transition variance structure was explored. Transition variance refers to how participants move, or remain

stable, across time. Transition invariance would indicate that participants from each profile transition at similar rates between timepoints. Transition invariance and noninvariance models were compared using the LRDT and comparing the AIC and BIC in Table 4.5. The LMM model that freed the transitions between profiles across time was preferred to the LMM model that constrained transitions to be equal.

Table 4.5

Estimating Longitudinal Mixture Model (LMM) Variance Structure for LMM Step-3 Testing Transition Variance Structure

Model	LL	SC	AIC	BIC	*df*	cd	TR_{cd}	*p* value
Invariant transitions	-154435.78	3.84	308993.55	309477.88	61			
Variant transitions	**-154307.71**	**3.6605**	**308755.41**	**309311.20**	**70**	**2.42**	**105.98**	**< .001**

Note. Bolded text reflects the selected model. LL = log likelihood; SC = Scaling Correction; AIC = Akaike information criterion; BIC = Bayesian information criterion; cd = $(d\,f_0 \times sc_0 - d\,f_1 \times sc_1)/(d\,f_0 - d\,f_1)$; $TR_{cd} = -2 \times (L_0 - L_1)/cd$.

Step-4. Included Covariates

Once the measurement and transition structures to the data were explored and the final model was selected, it was appropriate to integrate covariates into the LMM model, the syntax for this final model with covariates can be seen in Appendix D. To better understand the context of the profiles, time-invariant covariates of gender, socioeconomic status, and race were added to the LMM model. Using the normative profile as the reference group, Table 4.6 displays the results.

Several covariates had significant associations with LPAs at each timepoint. In adolescence, significantly fewer males and African-American participants were in the alcohol and cannabis profile compared to the normative profile. Furthermore, there were fewer participants in the alcohol and cannabis profile who had parents who had

Table 4.6

Results of the LMM for Question 1: Demographic Covariates Associated with Latent Profile at Each Stage of Development, Referenced to a Normative Profile

Covariates	OR	*SE*	*p*	OR	*SE*	*p*	OR	*SE*	*p*
Adolescence									
Male	0.75	0.09	.003	0.86	0.13	.29	1.64	0.35	.07
SES									
Less than HS	0.74	0.17	.12	0.89	0.28	.68	0.97	0.36	.93
High school	0.730	0.17	.06	1.01	0.26	.97	0.67	0.22	.14
Some college	0.97	0.19	.87	0.80	0.21	.34	0.64	0.23	.11
College	**0.59**	0.13	.001***	0.66	0.19	.07	0.51	0.20	.01**
Race									
White	1.74	0.53	.17	2.99	1.42	.16	1.01	0.93	.99
Black	0.40	0.14	< .001***	0.81	0.51	.72	0.38	0.36	.08
Asian	0.91	0.39	.81	2.28	1.00	.20	0.44	0.46	.11
Native	1.65	0.46	.15	1.70	0.53	.19	1.17	0.59	.78
Other	1.37	0.43	.39	2.61	0.97	.10	0.91	0.90	.92
Emerging adulthood									
Male	0.75	0.09	.003	0.86	0.13	.29	1.64	0.35	.07
SES									
Less than HS	0.74	0.17	.12	0.89	0.28	.68	0.97	0.36	.93
High school	0.730	0.17	.06	1.01	0.26	.97	0.67	0.22	.14
Some college	0.97	0.19	.87	0.80	0.21	.34	0.64	0.23	.11
College	**0.59**	**0.13**	**.001*****	0.66	0.19	.07	**0.51**	**0.20**	**.01****
Race									
White	1.74	0.53	.17	2.99	1.42	.16	1.01	0.93	.99
Black	0.40	0.14	< .001***	0.81	0.51	.72	0.38	0.36	.08
Asian	0.91	0.39	.81	2.28	1.00	.20	0.44	0.46	.11
Native	1.65	0.46	.15	1.70	0.53	.19	1.17	0.59	.78
Other	1.37	0.43	.39	2.61	0.97	.10	0.91	0.90	.92
Young adulthood									
Male	0.75	0.09	.003	0.86	0.13	.29	1.64	0.35	.07
SES									
Less than HS	0.74	(0.17)	.12	0.89	(0.28)	.68	0.97	(0.36)	.93
High school	0.73	(0.17)	.06	1.01	(0.26)	.97	0.67	(0.22)	.14
Some college	0.97	(0.19)	.87	0.80	(0.21)	.34	0.64	(0.23)	.11
College	**0.59**	(0.13)	.001***	0.66	(0.19)	.07	0.51	(0.20)	.01**
Race									
White	1.74	(0.53)	.17	2.99	(1.42)	.16	1.01	(0.93)	.99
Black	0.40	(0.14)	<.001***	0.81	(0.51)	.72	0.38	(0.36)	.08
Asian	0.91	(0.39)	.81	2.28	(1.00)	.20	0.44	(0.46)	.22
Native	1.65	(0.46)	.15	1.70	(0.53)	.19	1.17	(0.59)	.78
Other	1.37	(0.43)	.39	2.61	(0.97)	.10	0.91	(0.90)	.92

** $p < .01$.
*** $p < .001$.

completed college degrees compared to participants in the normative profile. During adolescence, there were no demographic characteristics that were significantly associated with the low polysubstance profile. Participants in the high polysubstance profile during adolescence were less likely to have parents with a college degree compared to the normative profile.

During emerging adulthood, there were substantial shifts in demographic characteristics of profiles compared to what was observed during adolescence. In emerging adulthood, the alcohol and cannabis profile contained had significantly more male students, had more Caucasian participants, and fewer African-American participants compared to the normative profile. Interestingly, SES measured through parent educational attainment switched directions from what was seen during adolescence. During emerging adulthood, alcohol and cannabis profile participants were more likely to have a parent who had a college degree and less likely to have parents with only a high school degree than what was seen in the normative profile.

During emerging adulthood, a single covariate emerged as significant for participants in the low polysubstance profile. Participants in this profile were 2.3 times more likely to be male compared to the normative profile. Participants in the high polysubstance use profile during emerging adulthood were more likely to be male and less likely to be African American compared to the normative profile. Additionally, participants in the high polysubstance use profile during emerging adulthood were less likely to have a parent who had less than a high school diploma compared to the normative profile.

In young adulthood there were again substantial changes in significant demographic covariates by latent profile. The cannabis profile had more males and African Americans than the normative profile. The low polysubstance profile was half as likely to be African American compared to the normative profile. Finally, the high illicit profile contained more males, fewer participants with parents with a college degree, and fewer Asian-Americans than was seen in the normative population.

To explore the extent to which individuals transition between substance misuse patterns across development, the transition matrices produced from the longitudinal mixture model were explored. The transition and stability patterns reveal insights that build on our current knowledge of substance use during the transition to adulthood.

Transition Patterns

Substantial transitions were seen in the latent transition model between substance use profiles across development (see Table 4.7). The most prominent transition across all timepoints was movement towards the normative profile. Between adolescence and emerging adulthood, the transition to the normative profile from a non-normative profile ranged between 64.8% to 75.8%. During adolescence 1,568 participants were estimated to be in a non-normative profile. Given the transition probabilities, an estimated 1,205 of the adolescence transitioned to normative during emerging adulthood. Between emerging adulthood and young adulthood, the transition to the normative profile from another profile ranged between 45.1% to 69.5%. During emerging adulthood, an estimated 2,316 participants were in the nonnormative profile. Of the non-normative participants during emerging adulthood, 1,489 were estimated to transition to the normative profile.

Table 4.7

Final Longitudinal Mixture Model (LMM) Latent Transition Probabilities for Answering Research Question 1

Transitions		Alcohol/cannabis	Low poly	High poly	Normative
		Emerging adulthood			
Adolescence	Alcohol/cannabis	.11	.05	.08	.76
	Low poly	.21	.06	.08	.65
	High poly	.13	.12	.11	.65
	Normative	.08	.02	.04	.86
		Young adulthood			
Emerging adulthood	Alcohol/cannabis	.19	.06	.06	.70
	Low poly	.26	.16	.13	.45
	High poly	.24	.09	.07	.60
	Normative	.07	.02	.01	.90

There was also movement away from normative substance use. While the overall transition probabilities from the normative to profile to a non-normative profile between adolescence and emerging adulthood were small, 1.6% to 8.3%, the actual number of participants transitioning was quite large. Between adolescence and emerging adulthood 2,387 were estimated to transition to a non-normative profile. The transition from the normative profile to a non-normative profile reduced between emerging adulthood and young adulthood, only an estimated 1,554 participants made the switch to a riskier substance use profile.

Among the non-normative profiles, the largest transitions were seen between the two polysubstance use profiles moving to the alcohol and cannabis profile during emerging adulthood and the cannabis profile during young adulthood.

Stability Patterns

The longitudinal mixture model utilized in this analysis does not produce transition stabilities in the strictest sense. True stabilities exist within models with measurement invariance (i.e., the indicator variables are endorsed at the same rate within a profile across time). This was not true for the LMM model that best reflected the underlying data. In a looser sense, the stabilities can be interpreted between profiles that have a consistent interpretation. For this analysis stabilities were interpreted for the normative and low polysubstance profiles across all developmental periods. Furthermore, the stabilities between the alcohol and cannabis profile and high polysubstance profiles were interpreted between adolescence and emerging adulthood.

The stabilities patterns between adolescence and emerging adulthood are expressed along the diagonal of Table 4.7. The only substantial stability in substance use profiles between adolescence and emerging adulthood was for the normative profile. Between adolescence and emerging adulthood, approximately 86.2% (14,922 individuals) of the normative participants remained normative at emerging adulthood. Roughly 10% of participants remained stable in the alcohol and cannabis profile and the high polysubstance profile. 5.6% of participants maintained a pattern of low polysubstance use between adolescence and emerging adulthood.

In young adulthood two profiles previously identified in adolescence and emerging adulthood no longer exist and two new profiles emerged. The cannabis profile is defined by daily cannabis use and the high illicit substance use profile is defined by nearly daily illicit drug use. This change in profile meanings makes it impossible to

interpret stabilities among profiles across time. However, two profiles remain stable between emerging adulthood, the normative and low polysubstance use profiles. The normative profile stability probability remains high, 90.3% or 14,481 individuals. Participants with a normative pattern of substance use are highly likely to remain in the normative profile across time. The stability for the low polysubstance use profile

Research Question 2

MS Step-1. Sketch MS Model

The first step in building a MS model with multiple timepoints and complexed schemas was to sketch the expected transition matrices of the mover-stayer profiles. This can be seen in Table 4.8. The Stable Normative profile contained participants who remained stable and normative across all three timepoints. The matured-out classification contained a wide variety of possible transitions, but each of the transitions terminated with Normative use by young adulthood. The final mover-stayer profile captured all participants who were still using in the Continuing Users profile.

MS Step-2: Manipulate LTA Transition Matrices

In step 2, the transition matrices obtained from the LMM were merged with the sketched mover-stayer design. Where the rows no longer equal 1, as expected in transition probability matrices, the rows were adjusted to equal 1. The table with the adjusted transitions, with all rows summing to 1 is displayed in Table 4.9.

Table 4.8

Sketched Mover-Stayer (MS) Matrices for Answering Research Question 2: MS Step 1

Transitions		Alcohol/ cannabis	Low poly	High poly	Normative	Heading		Alcohol/ cannabis	Low poly	High poly	Normative
		Emerging adult						Young adulthood			
Stable normative											
Adolescence	Alcohol/cannabis	0	0	0	0	Emerging adult	Alcohol/cannabis	0	0	0	0
	Low poly	0	0	0	0		Low poly	0	0	0	0
	High poly	0	0	0	0		High poly	0	0	0	0
	Normative	0	0	0	1		Normative	0	0	0	1
Matured out											
Adolescence	Alcohol/cannabis	*	*	*	*	Emerging adult	Alcohol/cannabis	0	0	0	0
	Low poly	*	*	*	*		Low poly	0	0	0	0
	High poly	*	*	*	*		High poly	0	0	0	0
	Normative	*	*	*	0		Normative	0	0	0	1
Continuing users											
Adolescence	Alcohol/cannabis	*	*	*	*	Emerging adult	Alcohol/cannabis	*	*	*	0
	Low poly	*	*	*	*		Low poly	*	*	*	0
	High poly	*	*	*	*		High poly	*	*	*	0
	Normative	*	*	*	*		Normative	*	*	*	0

* Refers to an unknown transition probability that must be estimated from the transition matrix generated in the LMM.

Table 4.9

Base Theoretical Mover-Stayer (MS) Matrices for Research Question 2: MS Step-2

Transition 1		Alcohol/ cannabis	Low poly	High poly	Normative	Transition 2		Alcohol/ cannabis	Low poly	High poly	Normative
		Emerging adult						Young adulthood			
Stable normative											
Adolescence	Alcohol/cannabis	0.00	0.00	0.00	0.00	Emerging adult	Alcohol/cannabis	0.00	0.00	0.00	0.00
	Low poly	0.00	0.00	0.00	0.00		Low poly	0.00	0.00	0.00	0.00
	High poly	0.00	0.00	0.00	0.00		High poly	0.00	0.00	0.00	0.00
	Normative	0.00	0.00	0.00	1.00		Normative	0.00	0.00	0.00	1.00
Matured out											
Adolescence	Alcohol/cannabis	0.11	0.05	0.08	0.76	Emerging adult	Alcohol/cannabis	0.00	0.00	0.00	1.00
	Low poly						Low poly	0.00	0.00	0.00	1.00
	High poly						High poly	0.00	0.00	0.00	1.00
	Normative						Normative	0.00	0.00	0.00	1.00
Continuing users											
Adolescence	Alcohol/cannabis	0.11	0.05	0.08	0.76	Emerging adult	Alcohol/cannabis	0.62	0.18	0.20	0.00
	Low poly	0.21	0.06	0.08	0.67		Low poly	0.47	0.29	0.24	0.00
	High poly	0.13	0.12	0.11	0.65		High poly	0.61	0.23	0.17	0.00
	Normative	0.08	0.02	0.04	0.86		Normative	0.70	0.16	0.13	0.00

Note. Matrices estimated by merging the theoretical model from Table 4.8 and the transition probabilities from the LMM in Table 4.7.

MS Step-3: Transform Transition Probabilities

Transformations from probabilities to logits were conducted in Step 3. This prepared the transitions to be utilized in the logit parameterizations. Where the probability parameterization was used, the values from Table 4.10 were directly used, without transformation, in the Mplus syntax (the code for the probability parameterization can be seen in Appendix E). Since the logit parameterization is the preferred model, if sufficient separation between second-order, mover-stayer latent variables can be produced, Step 3 was followed to prepare probabilities for use in the logit parameterization. For this analysis, the Low Polysubstance profile was used as the reference profile for generating logits. Table 4.10 provides the logits used from the first estimation of the MS model.

MS Step-4 & 5: Apply Constrains and Assess Classification Efficacy

The values derived from the transformations from MS Step-3 were applied to the LMM model as transition constraints on the second-order, mover-stayer latent variable model. The syntax for the bases model can be seen in Appendix F. After running this first model, the output contained substantial misclassification, see Figure 4.5. The misclassification was derived from large portions of Matured-Out profile participants being classified among Stable Normative users. This can be seen with the light gray lines (Stable Normative) originating in non-normative profiles during adolescence which transitioning to normative use in emerging adulthood. This pattern should be classified as Matured-Out. A second general pattern of misclassification was seen with Continuing

Table 4.10

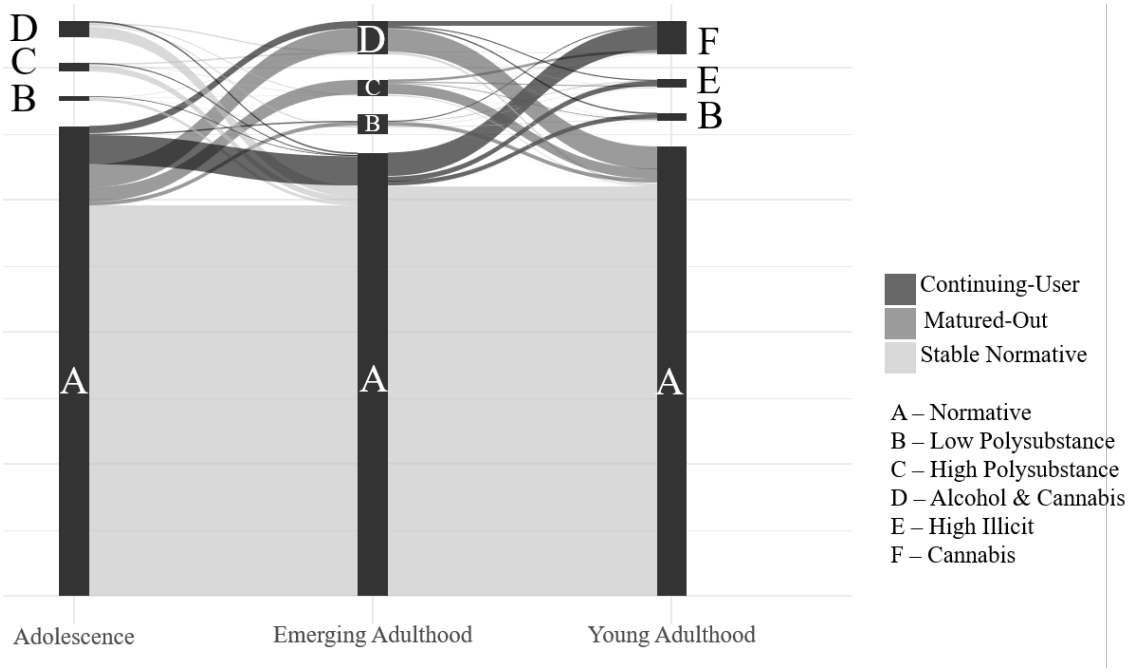
Logit Transformations of Base Mover-Stayer (MS) Matrices for Research Question 2: MS Step-3

Transition 1		Alcohol/ cannabis	Normative	High poly	Transition 2		Alcohol/ cannabis	Normative	High poly
		Emerging adult					Young adulthood		
		Stable normative							
Adolescence	Alcohol/cannabis	0.00	0.00	0.00	Emerging adult	Alcohol/cannabis	0.00	0.00	0.00
	Normative	0.00	13.82	0.00		Normative	0.00	13.82	0.00
	High poly	0.00	0.00	0.00		High poly	0.00	0.00	0.00
		Matured out							
Adolescence	Alcohol/cannabis	0.90	2.69	0.60	Emerging adult	Alcohol/cannabis	0.00	13.82	0.00
	Normative	1.49	-16.38	0.81		Normative	0.00	13.82	0.00
	High poly	0.23	1.88	-0.08		High poly	0.00	13.82	0.00
		Continuing users							
Adolescence	Alcohol/cannabis	0.90	2.69	0.60	Emerging adult	Alcohol/cannabis	1.28	-16.66	0.18
	Normative	1.49	2.75	-0.15		Normative	1.52	-16.66	-0.15
	High poly	0.23	1.88	-0.08		High poly	0.19	-16.66	-0.05

Note. Alcohol/cannabis = Alcohol and Cannabis latent profile, High Poly = High Polysubstance latent profile.

Figure 4.5

Mover-Stayer Classification Efficacy From the Base Model for Research Question 2: MS Step-5



Users (those terminating in a nonnormative profiles) being classified as stable non-users. This can be seen with the light gray transition patterns that terminate in the non-normative profile during emerging adulthood. Entropy for the MS model was 0.85 with an AIC of 43,303.91 and a BIC of43,531.50. Adjustments were made to the MS model constraints to improve classification.

Specifically, the constraints were improved to better distinguish between Stable Normative participants and Matured-Out users. Additionally, the constraints were made to better separate Continuing Users from the Stable Normative mover-stayer profile. Table 4.11 displays the adjusted logit constraints used in the MS model. Figure 4.6 illustrates the final MS model classification efficacy. Improvements can be seen in the

Table 4.11

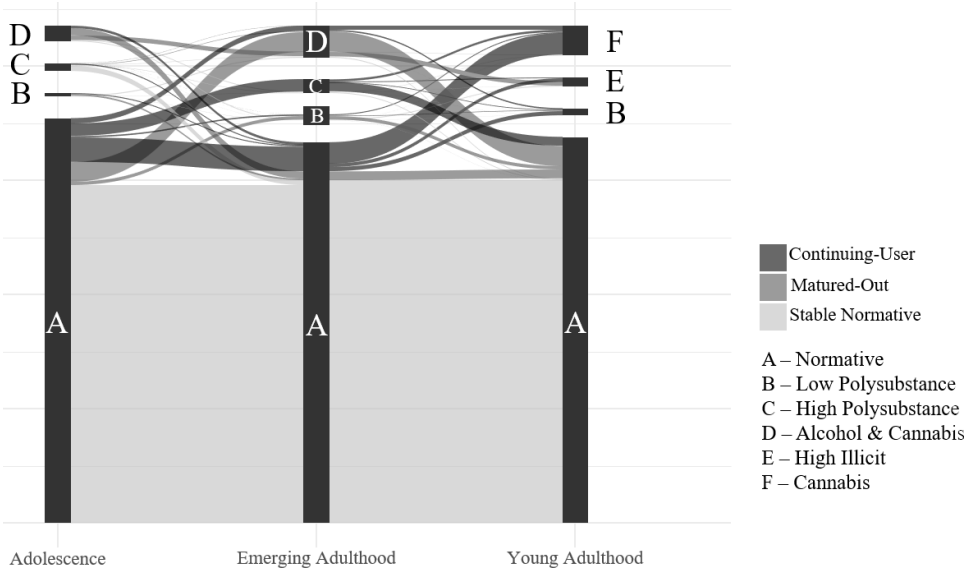
Logit Transformations of Adjusted Mover-Stayer (MS) Matrices for Research Question 2: MS Step-3 Repeated to Improve Classification Efficacy

Transition 1		Alcohol/ cannabis	Normative	High poly	Transition 2		Alcohol/ cannabis	Normative	High poly
		Emerging adult					Young adulthood		
		Stable normative							
Adolescence	Alcohol/cannabis	1.27	-18.42	1.75	Emerging adult	Alcohol/cannabis	1.28	-16.66	-.18
	Normative	0.00	13.82	0.00		Normative	0.00	13.82	0.00
	High poly	0.91	-18.42	-0.16		High poly	1.52	-16.56	-0.15
		Matured out							
Adolescence	Alcohol/cannabis	1.28	5.60	0.18	Emerging adult	Alcohol/cannabis	0.00	13.82	0.00
	Normative	1.52	-18.42	-0.15		Normative	0.00	13.82	0.00
	High poly	0.91	2.91	-0.16		High poly	0.00	13.82	0.00
		Continuing users							
Adolescence	Alcohol/cannabis	1.28	2.69	0.18	Emerging adult	Alcohol/cannabis	1.28	-10.86	0.18
	Normative	-2.65	-4.19	-4.33		Normative	1.52	-9.55	-0.15
	High poly	-0.92	1.91	-0.16		High poly	-.91	-11.41	-0.16

Note. Alcohol/cannabis = Alcohol and Cannabis latent profile, High Poly = High Polysubstance latent profile.

Figure 4.6

Mover-Stayer Classification Efficacy From the Adjusted Model for Research Question 2: MS Step-5



classification of Matured-Out users and Continuing Users. Entropy for the final MS model was 0.93, with an AIC of 44,805.89 and a BIC of 45,033.48. While the AIC and BIC were higher for the adjusted model the increase in entropy provides substantial benefits to answer Research Question 2, which relied on appropriate classifications into the second-order, mover-stayer latent model.

In Step 4, the MS model was also tested using the probability parameterization, the syntax is available in Appendix E. The MS model using the probability parameterization with the same adjustments from the adjusted logit model seen in Table 4.11 resulted in a nicely specified model, classification was better than what was seen in the logit parameterization with an entropy of 0.95. However, given the benefits of being able to extend the MS model to incorporate covariates and distal outcomes, the small gain

in entropy, 0.93 to 0.95, still favored the use of the logit parameterization. The logit parameterization was utilized for all remaining analyses.

MS Step-6: Include Covariates

Covariates were not included in this part of the analysis. Instead Question 2 is concerned with distal outcomes.

MS Step-7: Include Distal Outcomes

Self-sufficiency outcomes that reflect young adult autonomy, personal responsibility, and financial independence were incorporated into the MS model as means within the mover-stayer classes. The MS model was estimated holding distal outcome mean to the grand mean across mover-stayer profile. An example of the syntax used to estimate the means can be seen in Appendix G. The MS model was also estimated allowing for the free estimation of means within each mover-stayer profile. Models were compared using LLDT to identify if the constrained or freely estimated mean model was preferred, as seen in Table 4.12. Where the freely estimated mean model was preferred, a mean difference test was conducted to identify which mover-stayer profiles varied from the mean of the normative profile. Given that several models were estimated the standard for significance was raised, such that a *p* value of .01 or less was considered a statistically significant difference.

Model comparison between constrained and free mean models identified which variables within the three domains of young adult outcomes (personal autonomy, personal responsibility, and financial independence) showed significant difference.

Table 4.12

Mover-Stayer (MS) Model Comparisons Between Constrained Young Adult Self-Sufficiency Outcomes and Freely Estimated Young Adult Self-Sufficiency Outcomes for Research Question 2: MS Step-7

Self-sufficiency variables	Log likelihood (L)	Scaling correction (sc)	AIC	BIC	*df*	cd	TRd	*p*
			Personal autonomy					
Personal mastery								
Constrained	-60108.55	2.39	120213.10	120345.10	13			
Free	-60092.71	2.35	120215.40	120333.10	15	2.09	15.16	< .001
Stress								
Constrained	-60648.76	2.23	121323.50	121425.50	13			
Free	-60575.75	2.21	121181.50	121299.20	15	2.08	70.20	< .001
			Personal responsibility					
Criminality								
Constrained	-47971.20	4.32	95968.39	96070.42	13			
Free	-44873.91	4.62	89777.81	89895.53	15	6.57	942.86	< .001
			Financial independence					
Independent living								
Constrained	-31490.87	2.23	63007.75	63109.77	13			
Free	-31481.70	2.22	2993.39	63111.11	15	2.16	8.51	.02
Economic distress								
Constrained	-48379.65	2.53	96785.29	96887.31	13			
Free	-48272.17	2.51	96574.31	96692.06	15	2.38	90.32	< .001

Note. cd = (df0 * sc0 - df1 * sc1) / (df0 – df1) TRcd = -2 * (L0 – L1) / cd.

The scales that reflected personal autonomy, personal mastery and stress, were best reflected by the free mean models indicating significant differences between scale means existed between profiles. The scale reflecting personal responsibility, criminality, was best represented by a model that allowed the free estimation of means, indicating mean differences between mover-stayer profiles. The scale in the domain of financial

independence that represented living independently was best represented by a single mean. In each mover-stayer profile independent living was estimated to be 77.1%. The mean of economic distress, however, was best estimated by the free mean model.

The means of the Stable Normative profile were used as the standard for mean comparisons. The means of personal mastery, stress, criminality, and economic distress for the Matured-Out and continuing-user profiles can be seen in Table 4.13.

Table 4.13

Mean Differences Between Mover-Stayer (MS) Profiles on Young Adult Self-Sufficiency Outcomes for Research Question 2: MS Step-7 Continued

Self-sufficiency variables	*N*	n	*M*	*SE*	*z*	Hedge's g	Rate	RR	WMR r	Effect
				Personal autonomy						
Personal mastery										
Stable normative	15,005		19.42	0.04						
Matured out	1,539		19.43	0.12	0.19					
Continuing user	**2,378**		**19.02**	**0.09**	**-9.48**	**0.08**				**Small**
Stress										
Stable normative	15,005		4.71	0.04						
Matured out	1,539		4.76	0.12					0.01	
Continuing user	**2,378**		**5.59**	0.10					**0.09**	**Small**
				Personal responsibility						
Criminality										
Stable normative	15,005	2,761	0.24	0.01			0.18			
Matured out	**1,539**	**527**	**0.31**	**0.03**			**0.34**	**1.86**		**Small**
Continuing user	**2,378**	**2,265**	**6.53**	**0.21**			**0.95**	**5.18**		**Large**
				Financial independence						
Living independently			0.77	0.18						
Economic distress										
Stable normative	15,005	7,632	0.70	0.02						
Matured out	1,539	815	0.71	0.05					< 0.001	
Continuing user	**2,378**	**2,375**	**1.18**	**0.05**					**0.11**	**Small**

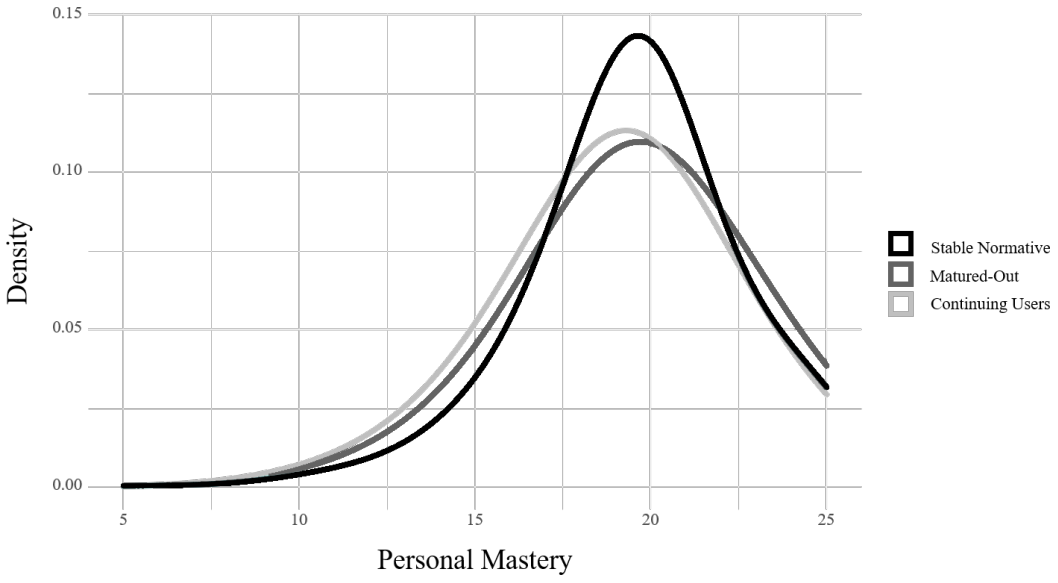
Note. N = sample size; n = number of events; RR = rate ratio; WMW = Wilcoxon-Mann-Whitney.

Personal Autonomy

Personal autonomy reflects an individuals' ability to control and direct their life. Significant differences in this ability appeared between mover-stayer profiles. Specifically, personal mastery for Stable Normative and Matured-Out profiles were similar with scores of 19.42 and 19.43, respectively. The mean for personal mastery within the Continuing Users profile was significantly low than the Stable Normative profile. Figure 4.7 illustrates the density curve by mover-stayer profile. The differences between the Stable Normative and Continuing User means corresponded to a small effect size (Hedge's g = 0.08).

Figure 4.7

Perceived Personal Mastery by Mover-Stayer Classification for Answering Research Question 2

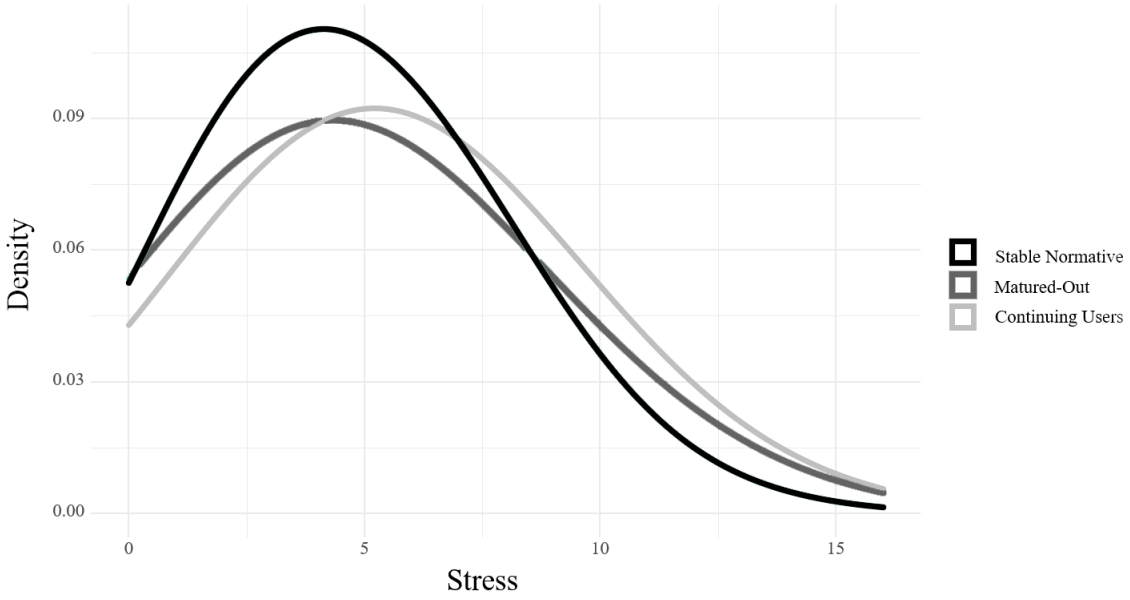


The stress scale also revealed significant differences between profiles (see Figure 4.8. In all, each mover-stayer profile had stress scores that reflected lower perceived

stress with averages between 4 and 6 on a scale with the range of 0 to 16. When means were compared, the Stable Normative and Matured-Out profiles were not significantly different, 4.71 and 4.6. The mean difference between the Stable Normative and Continuing Users profiles were statistically significant. Indicating that on average, Continuing Users perceive more stress in their daily lives than individuals in the Stable Normative profile. The mean difference corresponded to a small effect size, Wilcoxon-Mann-Whitney $r = 0.08$.

Figure 4.8

Perceived Stress by Mover-Stayer Classification for Answering Research Question 2



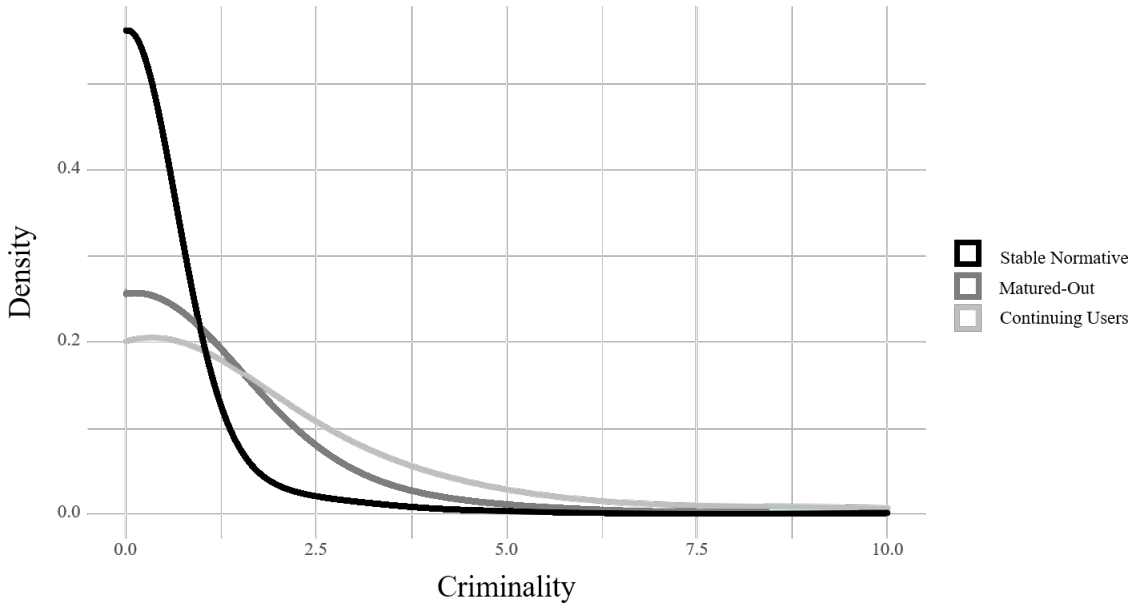
Personal Responsibility

Level of criminal behavior were compared between mover-stayer profiles, the differences in density curves can be seen in Figure 4.9. Differences between Stable

Normative and Matured-Out profiles were significantly different. Participants in the Matured-Out profile experienced levels of criminality at twice the rate of participants in the normative population (rate ratio = 2.07). While the rate ratio indicated a doubling of criminal behavior in the Matured-Out profile, the rate of criminality in the Stable Normative population was low, 0.18. The doubled rate with in the Matured-Out profile remained low as well, 0.37. There was a significant difference between the rate of criminal behaviors between the Stable Normative profile (0.18) and the Continuing Users profile (1.06). Individuals in the Continuing Users profile engaged in criminal behaviors at a rate 5.9 times higher than the Stable Normative profile.

Figure 4.9

Criminality by Mover-Stayer Classification for Answering Research Question 2

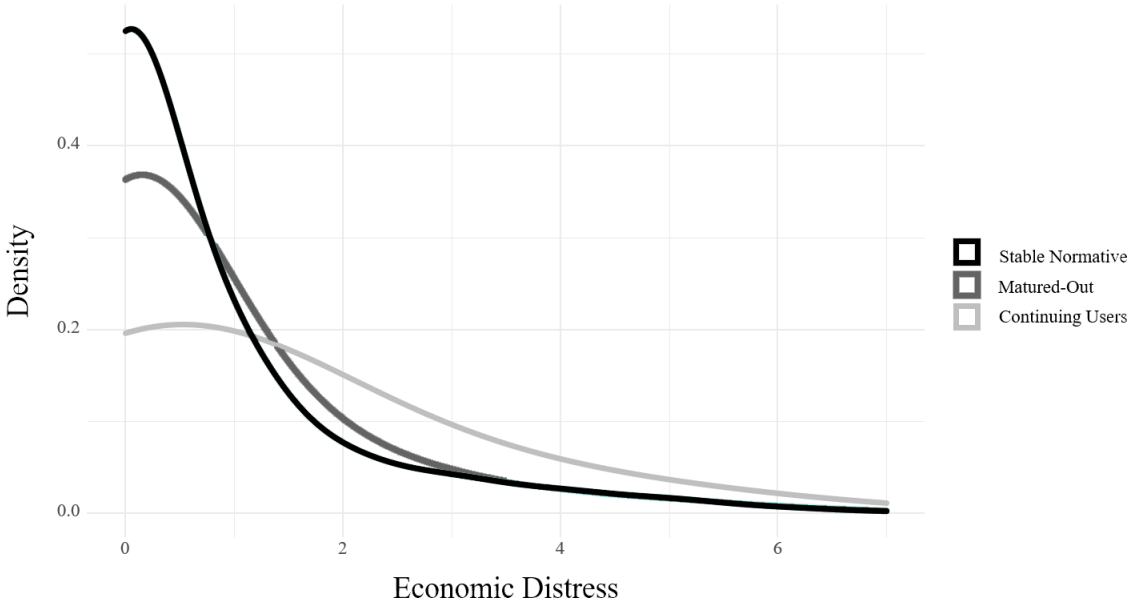


Financial Independence

Of the two scales used to represent financial independence in young adulthood, only economic distress showed significant differences between mover-stayer profiles. Each profile had a median of 0 economic distress events during the past year. This indicated that most participants in each profile did not experience economic distress. A visual comparison of the mover-stayer profiles can be seen in Figure 4.10. The comparison between the Stable Normative profile and the Matured-Out profile was not significant. The difference between the Stable Normative profile and the Continuing Users was significantly different, with the Continuing Users experiencing more economic distress events.

Figure 4.10

Economic Distress by Mover-Stayer Classification for Answering Research Question 2



Research Question 3

Research Question 3 builds on Research Question 2 by further parsing the continuing users mover-stayer profile into a continuing-cannabis users and continuing-illicit users profile. Given current public opinion and policy development surrounding cannabis use, Research Question 3 seeks to understand the young adult impacts of being a continuing-cannabis user. Using the foundation of the LMM established in Research Question 1 and following the outline steps for estimating a MS model, four theoretically relevant mover-stayer profiles were created: (1) stable normative, (2) matured-out, (3) continuing-cannabis users, and (4) continuing-illicit users.

MS Step-1: Sketch MS Model

The notable difference between the sketch from Research Question 2 and 3 is seen in newly parsed continuing-cannabis and continuing-illicit mover-stayer profiles. The continuing-cannabis profile captures participants that end in the cannabis profile at young adulthood and the continuing-illicit profile captures participants that end in the low polysubstance or high illicit use profiles at young adult measurement occasion. The stable normative profile and matured-out user sketches were identical to what was specified in Research Question 2. The sketched MS model for Question 3 is shown in Table 4.14.

MS Step-2: Manipulate LTA Transition Matrices

The separation of Continuing-Cannabis users from the Continuing-Illicit users required adjustments to the manipulated matrices for the new profiles. The adjusted transition probabilities can be seen in Table 4.15.

Table 4.14

Sketched Theoretical Mover-Stayer (MS) Matrices for Research Question 3: MS Step 1

Transition 1		Alcohol/ cannabis	Low poly	High poly	Normative	Transition 2		Alcohol/ cannabis	Low poly	High poly	Normative
		Emerging adult						Young adulthood			
		Stable normative									
Adolescence	Alcohol/cannabis	0	0	0	0	Emerging adult	Alcohol/cannabis	0	0	0	0
	Low poly	0	0	0	0		Low poly	0	0	0	0
	High poly	0	0	0	0		High poly	0	0	0	0
	Normative	0	0	0	1		Normative	0	0	0	1
		Matured out									
Adolescence	Alcohol/cannabis	*	*	*	*	Emerging adult	Alcohol/cannabis	0	0	0	1
	Low poly	*	*	*	*		Low poly	0	0	0	1
	High poly	*	*	*	*		High poly	0	0	0	1
	Normative	*	*	*	0		Normative	0	0	0	1
		Continuing cannabis									
Adolescence	Alcohol/cannabis	*	*	*	*	Emerging adult	Alcohol/cannabis	1	0	0	0
	Low poly	*	*	*	*		Low poly	1	0	0	0
	High poly	*	*	*	*		High poly	1	0	0	0
	Normative	*	*	*	*		Normative	1	0	0	0
		Continuing illicit									
Adolescence	Alcohol/cannabis	*	*	*	*	Emerging adult	Alcohol/cannabis	0	*	*	0
	Low poly	*	*	*	*		Low poly	0	*	*	0
	High poly	*	*	*	*		High poly	0	*	*	0
	Normative	*	*	*	*		Normative	0	*	*	0

* Refers to an unknown transition probability that must be estimated from the transition matrix generated in the LMM.

Table 4.15

Adjusted Theoretical Mover-Stayer (MS) Matrices for Research Question 3: MS Step-2

Transition 1		Alcohol/ cannabis	Low poly	High poly	Normative	Transition 2		Alcohol/ cannabis	Low poly	High poly	Normative
		Emerging adult						Young adulthood			
Stable normative											
Adolescence	Alcohol/cannabis	0.00	0.00	0.00	0.00	Emerging adult	Alcohol/cannabis	0.00	0.00	0.00	0.00
	Low poly	0.00	0.00	0.00	0.00		Low poly	0.00	0.00	0.00	0.00
	High poly	0.00	0.00	0.00	0.00		High poly	0.00	0.00	0.00	0.00
	Normative	0.00	0.00	0.00	1.00		Normative	0.00	0.00	0.00	1.00
Matured out											
Adolescence	Alcohol/cannabis	0.11	0.05	0.08	0.76	Emerging adult	Alcohol/cannabis	0.00	0.00	0.00	1.00
	Low poly	0.21	0.06	0.08	0.65		Low poly	0.00	0.00	0.00	1.00
	High poly	0.13	0.12	0.11	0.65		High poly	0.00	0.00	0.00	1.00
	Normative	0.60	0.12	0.28	0.00		Normative	0.00	0.00	0.00	1.00
Continuing cannabis											
Adolescence	Alcohol/cannabis	0.11	0.05	0.08	0.76	Emerging adult	Alcohol/cannabis	1.00	0.00	0.00	0.00
	Low poly	0.21	0.06	0.08	0.65		Low poly	1.00	0.00	0.00	0.00
	High poly	0.13	0.12	0.11	0.65		High poly	1.00	0.00	0.00	0.00
	Normative	0.608	0.02	0.04	0.86		Normative	1.00	0.00	0.00	0.00
Continuing illicit											
Adolescence	Alcohol/cannabis	0.11	0.05	0.08	0.76	Emerging adult	Alcohol/cannabis	0.00	0.54	0.4	0.00
	Low poly	0.21	0.06	0.08	0.65		Low poly	0.00	0.46	0.54	0.00
	High poly	0.13	0.12	0.11	0.65		High poly	0.00	0.46	0.54	0.00
	Normative	0.608	0.02	0.04	0.86		Normative	0.00	0.49	0,51	0.00

Note. Matrices presented here were already adjusted from the base model for improved MS classification.

MS Step-3: Transform Transition Probabilities

The probabilities from Step 2, were transformed to logits in Step 3. Again, in this step any probability equal to 0 was adjusted to 0.000001 for calculating appropriate logits. The low polysubstance use profile was used as the reference profile for generating logits. Table 4.16 provides the logits used from the first estimation of the MS model.

MS Step-4 & 5: Apply Constrains and Assess Classification Efficacy

The values derived from the transformations from MS Step-3 were applied to the LMM model as transition constraints to estimate the MS model for Step-4. After running this first model, the output contained substantial misclassification with many transition patterns being specified within the Stable Normative profile. Entropy for the MS model was 0.90 with an AIC of 43594.75 and a BIC of 43688.92. Adjustments were made to improve the MS model specification and limit the number of patterns flowing into the Stable Normative profile. Full syntax for the final model can be seen in Appendix G. Entropy for the final model was 0.94, with an AIC of 45,499.82 and a BIC of 45,593.99. While the AIC and BIC were lower in the initial model, the gain in entropy which better reflected the theorized model led to the decision to select the adjusted model.

Figure 4.11 illustrates the transitions in substance use profiles across time by mover-stayer assignment. The majority of misclassification in the MS model was associated with patterns that were non-normative in adolescence who transition to normative use during emerging adulthood and then stay in normative profile through young adulthood.

Table 4.16

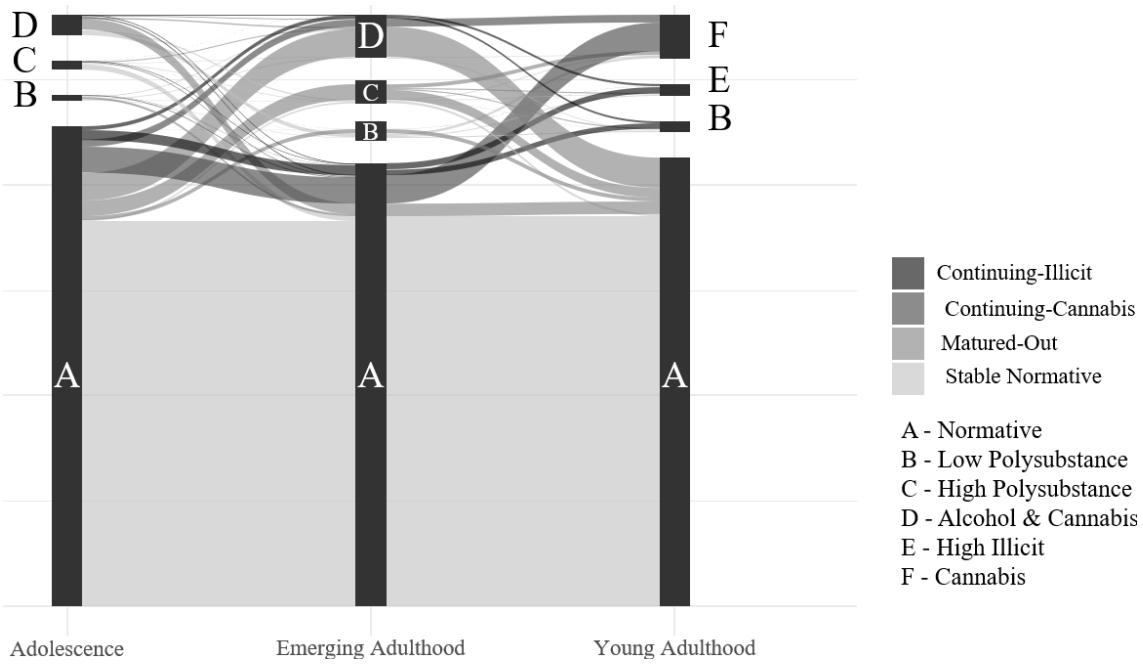
Logit Transformations of Adjusted Mover-Stayer (MS) Matrices for Research Question 3: MS Step-3

Transition 1		Alcohol/ cannabis	Normative	High poly	Transition 2		Alcohol/ cannabis	Normative	High poly
		Emerging adult					Young adulthood		
		Stable normative							
Adolescence	Alcohol/cannabis	-18.42	-18.42	2.30	Emerging adult	Alcohol/cannabis	2.30	-18.42	.30
	Normative	0.00	13.82	0.00		Normative	0.00	13.82	0.00
	High poly	2.30	-18.42	2.30		High poly	2.30	-18.42	2.30
		Matured out							
Adolescence	Alcohol/cannabis	0.90	2.69	0.60	Emerging adult	Alcohol/cannabis	0.00	45.00	0.00
	Normative	1.52	-16.12	-0.15		Normative	0.00	45.00	0.00
	High poly	0.23	1.88	-0.08		High poly	0.00	45.00	0.00
		Continuing users							
Adolescence	Alcohol/cannabis	0.90	0.82	0.60	Emerging adult	Alcohol/cannabis	45.00	0.00	0.00
	Normative	1.49	1.19	0.81		Normative	45.00	0.00	0.00
	High poly	0.23	0.31	-0.08		High poly	45.00	0.00	0.00
		Continuing illicit							
Adolescence	Alcohol/cannabis	0.90	2.69	0.81	Emerging adult	Alcohol/cannabis	-13.82	-13.82	0.18
	Normative	1.49	2.75	0.81		Normative	-13.82	-13.82	-0.15
	High poly	0.23	1.88	-0.08		High poly	-13.82	-13.82	-0.15

Note. Alcohol/cannabis = Alcohol and Cannabis latent profile, High Poly = High Polysubstance latent profile.

Figure 4.11

Mover-Stayer Classification Efficacy From the Adjusted Model for Research Question 3: MS Step-5



MS Step-6: Include Covariates

Covariates were not included in this part of the analysis. Instead Question 3 is concerned with distal outcomes.

MS Step-7: Included Distal Outcomes

Self-sufficiency outcomes that reflect young adult autonomy, personal responsibility, and financial independence were incorporated into the MS model as means within the mover-stayer profiles. The final model syntax can be seen in Appendix H. The MS model was estimated holding distal outcome means to the outcome specific grand mean across mover-stayer. The MS model was also estimated allowing for the free

estimation of means within each mover-stayer profile. Models were compared using LLDT to identify if the constrained or freely estimated mean model was preferred, results are shown in Table 4.17. Where the freely estimated mean model was preferred, a mean difference test was conducted to identify which mover-stayer profiles varied from the mean of the normative profile.

Table 4.17

Mover-Stayer (MS) Model Comparisons Between Constrained Young Adult Self-Sufficiency Outcomes and Freely Estimated Young Adult Self-Sufficiency Outcomes for Research Question 3: MS Step-7

Self-sufficiency variables	Log likelihood (L)	Scaling correction (sc)	AIC	BIC	*df*	cd	TRd	*p*
			Personal autonomy					
Personal mastery								
Constrained	-59691.23	2.24	119410.45	119520.3	14			
Free	-59680.06	2.21	119394.11	119527.50	17	2.07	10.79	.02
Stress								
Constrained	-60231.43	2.09	120490.86	120600.70	14			
Free	-60138.23	2.10	120310.49	121299.20	17	2.15	86.83	< .001
			Personal responsibility					
Criminality								
Constrained	-47619.86	4.15	95267.71	95377.86	14			
Free	-44050.67	4.79	88135.33	88268.75	17	7.78	917.92	< .001
			Financial independence					
Independent living								
Constrained	-31073.55	2.09	62175.10	62284.97	14			
Free	-31060.60	2.11	62155.19	62128.61	17	2.20	11.75	.01
Economic distress								
Constrained	-47962.32	2.37	95952.64	96062.51	14			
Free	-47839.85	2.45	95713.70	95847.11	11	2.82	86.75	< .001

Note. cd = (df0 * sc0 - df1 * sc1) / (df0 – df1) TRcd = -2 * (L0 – L1) / cd.

Model comparison between constrained and free mean models identified which variables within the three domains of young adult outcomes (personal autonomy, personal responsibility, and financial independence) showed significant difference. Mean comparison statistics are displayed in Table 4.18.

Table 4.18

Mean Differences Between Mover-Stayer (MS) Profiles on Young Adult Self-Sufficiency Outcomes for Research Question 3: MS Step-7 Continued

Self-sufficiency variables	*N*	n	*M*	*SE*	*z*	Rate	RR	WMR r	Effect
				Personal autonomy					
Personal mastery									
Stress									
Stable normative	15,513		4.72	0.04					
Matured out	1,544		4.77	0.12	1.40			0.01	
Continuing cannabis	**1,252**		**5.46**	**0.12**	**18.59**			**0.06**	**Small**
Continuing user	**609**		**6.24**	**0.21**	**38.03**			**0.08**	**Small**
				Personal responsibility					
Criminality									
Stable normative	15,513	2,508	0.18	0.01		0.16			
Matured out	**1,544**	**825**	**0.27**	**0.03**		**0.53**	**3.23**		**Moderate**
Continuing cannabis	**1,252**	**1,275**	**1.10**	**0.12**		**1.02**	**6.72**		**Large**
Continuing user	**609**	**945**	**6.90**	**0.31**		**1.55**	**9.38**		**Large**
				Financial independence					
Living independently			0.77	0.18					
Economic distress									
Stable normative	15,005	7,632	0l70	0.02					
Matured out	1,539	815	0.71	0.05				< 0.001	
Continuing user	**2,378**	**2,375**	**1.18**	**0.05**				**0.11**	**Small**

Note. N = sample size; n = number of events; RR = rate ratio; WMW = Wilcoxon-Mann-Whitney.

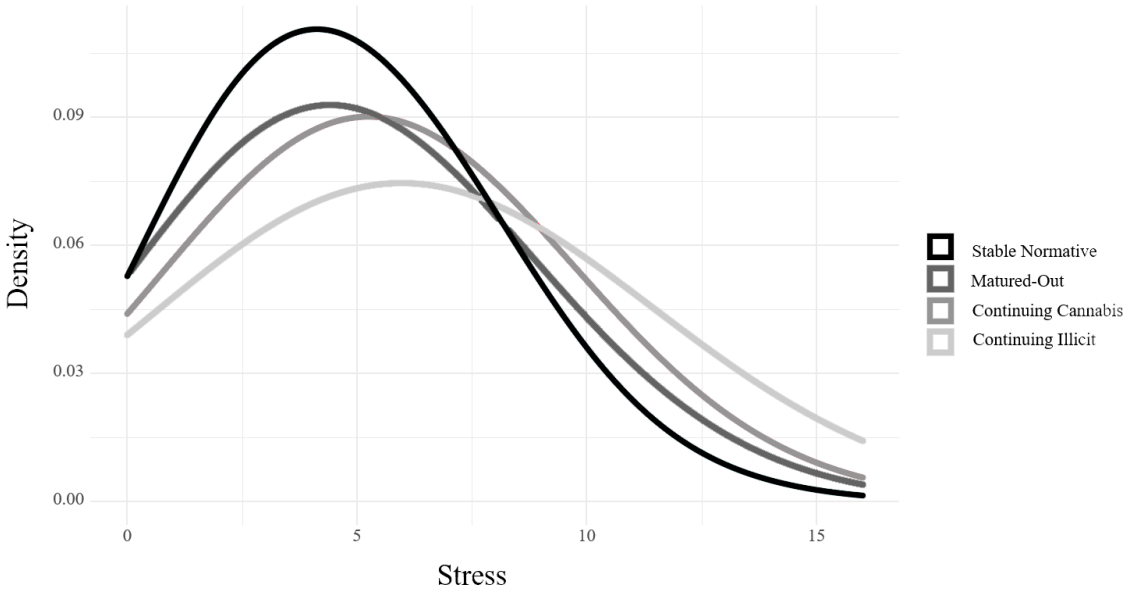
Personal Autonomy

Personal mastery across the four mover-stayer profiles were best represented by a single mean, 19.40. Perceived stress, on the other hand, was better reflected by freely

estimated means, see Figure 4.12. Compared to the Stable Normative profile, Continuing-Cannabis users and Continuing-Illicit users had significantly higher stress levels. Stable Normative users had a mean perceived stress of 4.71 and a median of 4.00. Continuing-Cannabis users had a mean of 5.46 and a median of 5.00. Continuing-Illicit users had a mean of 6.25 and a median of 6.00. The difference between profiles was estimated to be small, 0.06 and 0.08, respectively. The stress scaled had a range between 0 and 16, with 0 being the lowest perceived stress and 16 being the highest. Considering the range of the scale, all profiles central scores indicated relatively low levels of stress.

Figure 4.12

Stress by Mover-Stayer Classification for Answering Research Question 3



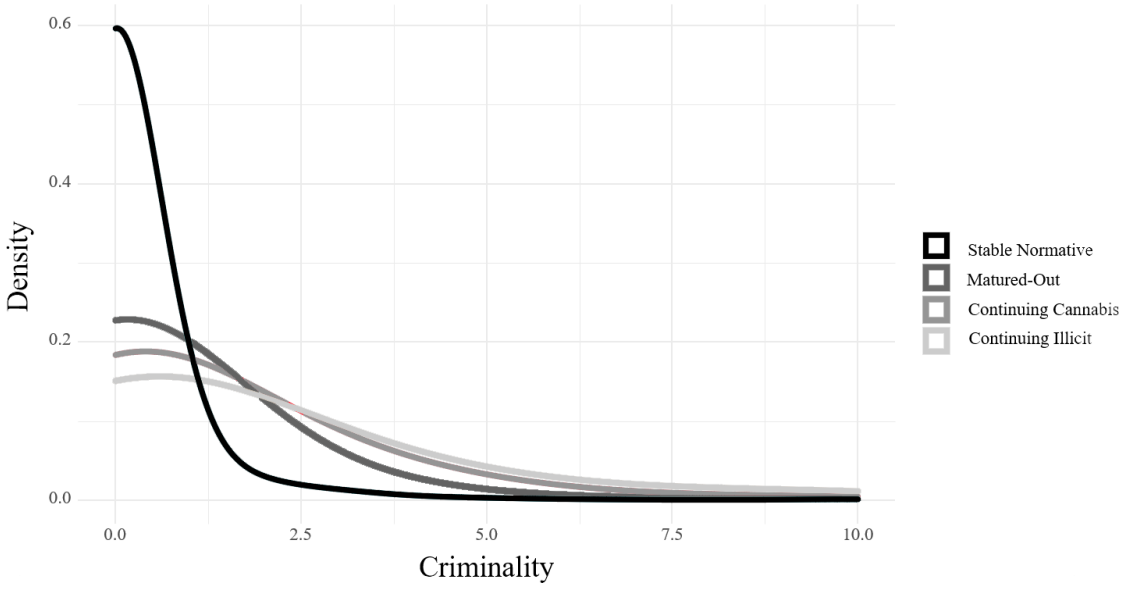
Personal Responsibility

Participants in the Stable Normative profile were much less likely to be involved in criminal behaviors compared to participants in any other profile (see Figure 4.13).

Stable Normative users had a criminality rate of 0.17. Participants in the Matured-Out profile had over double the rate of criminality seen in the Stable Normative profile (RR = 2.66). Participants in the Continuing-Cannabis profile engaged in criminal behavior at a rate 6 times higher than what was seen in the Stable Normative profile. Participants in the Continuing-Illicit profiles had rates of criminality nine times higher than the Stable Normative profile.

Figure 4.13

Criminality by Mover-Stayer Classification for Answering Research Question 3



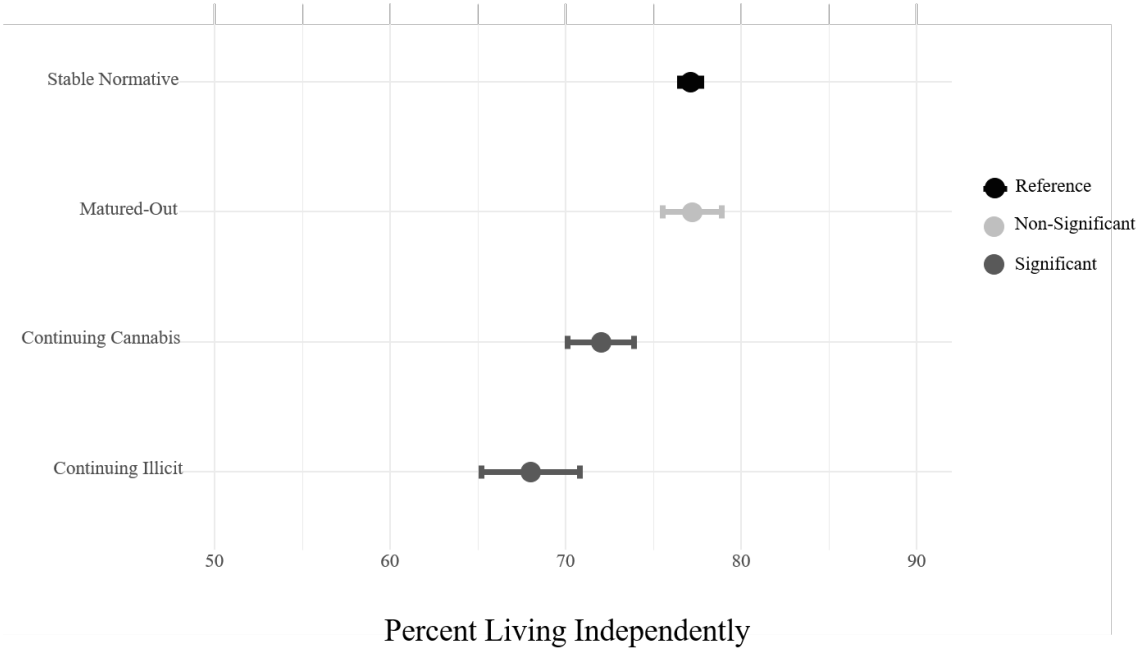
Financial Independence

Both items used to measure financial independence, living independently and economic distress, showed significant differences between mover-stayer profile. The proportion of participants living independently by young adulthood was equivalent between the Stable Normative and Matured-Out profiles. The proportion of participants

in the Continuing-Cannabis and Continuing-Illicit profiles were significantly less likely to be living independently than young adults in the Stable Normative profile, see Figure 4.14. The difference between each profile and the Stable Normative profile had a small effect, 0.03 and 0.12, respectively.

Figure 4.14

Living Independently by Mover-Stayer Classification for Answering Research Question 3

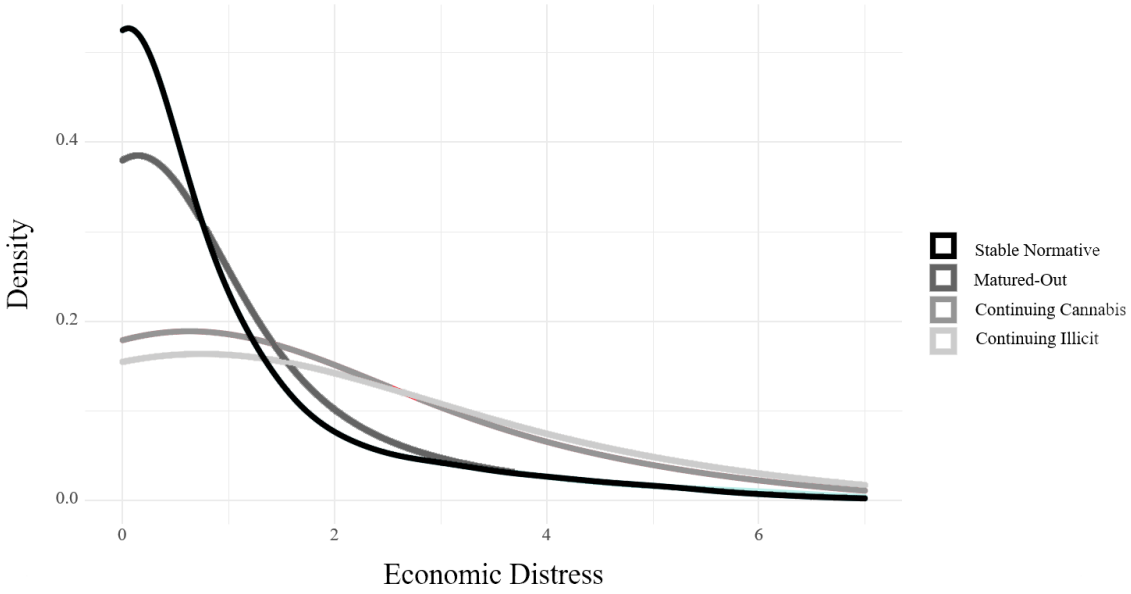


Economic distress varied by mover-stayer profiles. While the Stable Normative profile and the Matured-Out profile did not vary, both the Continuing-Cannabis and Continuing-Illicit profiles were significantly different than the Stable Normative profile. As seen in Figure 4.15, the density distributions of economic distress scores varied significantly. While most of all profiled experienced no economic distress event, the wider distribution of the Continuing-Cannabis and Continuing-Illicit profiles indicates

that many participants in these profiles did, in fact, experience economic distress events in the past year. The difference between profiles was estimated to be small, 0.10 for Continuing-Cannabis users and 0.08 for Continuing-Illicit users.

Figure 4.15

Economic Distress by Mover-Stayer Classification for Answering Research Question 3



Research Question 4

The final question proposed in this dissertation sought to identify the differences between those who Matured-Out of substance use and those who did not. Participant education attainment level, event-based developmental milestones (homeownership, marriage, and parenthood), and self-perceived adult statuses were regressed on mover-stayer profile. The syntax containing the predictor variables is available in Appendix H.

Prior to running the regression, the assumption of multicollinearity was explored.

The best way to detect multicollinearity in regression is by testing the variance inflation factor (VIF). Unfortunately, MPlus does not produce a VIF, requiring researchers to rely on zero-order correlations to identify possible sources of multicollinearity. Table 4.19 displays the zero-order correlations among independent variables. Most independent variables were significantly correlated with each other. However, correlational significance is swayed by sample size, such that, projects with large sample sizes could detect significant differences even when the relationship is small. Considering the effect size of the detected differences better describes the relationship. Significant correlations among the independent variables ranged from 0.03 to 0.43. According to Cohen (1988), none of the correlations were considered to have a large effect (0.50 or higher). Multicollinearity in the regression model is unlikely when variables have low to moderate correlation (Cohen et al., 2003).

Moderate correlations were seen being married and owning a house ($r = 0.36$) and being married and being a parent ($r = 0.40$), see Table 4.19. These milestones tend to cooccur at a moderate rate, yet homeownership and parenthood had only a small correlation ($r = 0.014$). Independent variables reflecting perceived development were also moderately correlated. Participants who viewed themselves as acting older than their same aged peers also perceived themselves as being more mature ($r = 0.38$) and more responsible ($r = 0.34$). Participants who perceived themselves as being more mature also believed they were more responsible ($r = 0.43$). There were, of course, correlations among the educational attainment levels since they were different levels of the same dummy-coded variable.

Table 4.19

Correlations Among Predictor Variables Used in Research Question 4

	1	2	3	4	5	6	7	8	9	10
Educational attainment										
1. < High school										
2. High school	-0.12									
3. Some college	-0.22	-0.33								
4. College	-0.14	-0.22	-0.39							
5. > College	-0.11	-0.17	-0.30	-0.20						
Event-based development										
6. Homeowner	-0.08	-0.03	-0.03	0.06	0.08					
7. Married	-0.03	0.01	0.03	-0.04	0.00	0.36				
8. Parent	0.10	0.11	0.11	-0.21	-0.17	0.14	0.40			
Self-perceived development										
9. Perceived age	0.03	-0.01	0.07	-0.08	-0.03	0.04	0.08	0.13		
10. Perceived maturity	0.02	0.04	0.06	-0.04	-0.01	0.03	0.06	0.07	0.38	
11. Perceived responsibility	0.03	0.01	0.07	-0.07	-0.06	0.05	0.11	0.02	0.35	0.43

After assessing threats to collinearity in the MS model, the multinomial regression was added to the MS model in MPlus. Educational attainment, event-based milestones of development, and self-perceived indicators of adulthood predicted mover-stayer profile. The Stable Normative profile was used as the reference category, all other mover-stayer profiles were interpreted relative to the Stable Normative profile. Relative risk ratios and percent change were used to interpret the impact of the variables on predicting mover-stayer profile membership. Results from the analysis can be seen in Table 4.20.

Predictors of Maturing-Out

Education, event-based, and self-perceived developmental markers predicted

participants membership in the different MS profiles, see Table 4.20. Results comparing the Matured-Out profile to the Stable Normative profile can be seen in Figure 4.16. Educational attainment was a dummy-coded variable with 5-levels. The reference category was completing a college degree. Participants in the Matured-Out profile had greater odds of having completed some college than having a college degree, compared to the Stable Normative profile. In fact, the odds of having some college were 26% higher compared to having completed a college education.

Table 4.20

Results of the Multinomial Regression for Answering Research Question 4

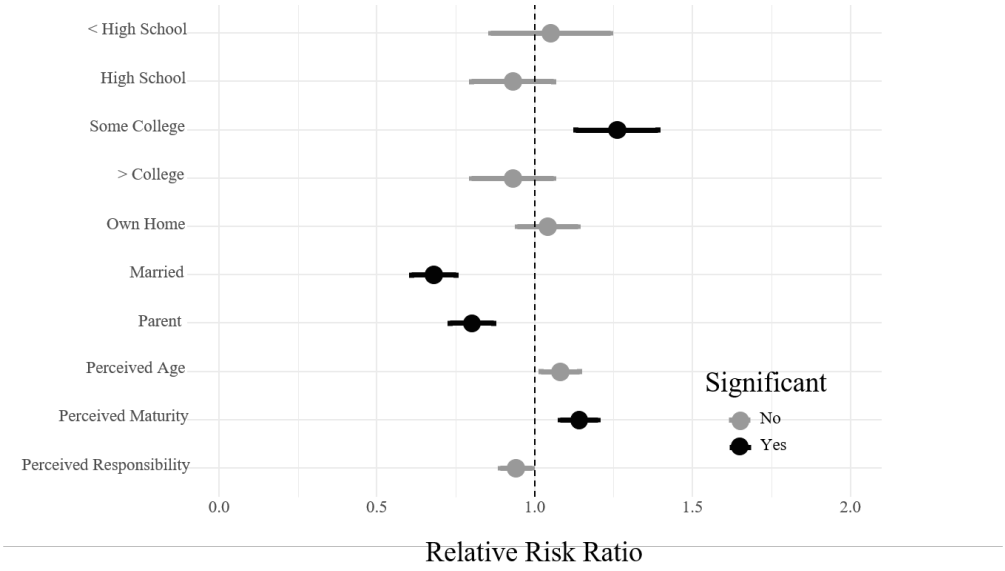
	Matured out				Continuing cannabis				Continuing illicit			
Predictor variables	RRR	*p*	SE	Δ%	RRR	*p*	SE	Δ%	RRR	*p*	SE	Δ%
Education attainment												
< High school	1.05		0.19	5.3	1.92	*	0.32	91.5	3.05	**	0.82	204.7
High school	0.93		0.13	7.3	1.94	**	0.32	93.8	3.71	+	0.40	271.1
Some college	1.26	*	0.13	26.0	1.77	**	0.25	76.6	1.86	*	0.38	86.3
College	0.93		0.13	6.9	0.40	**	0.11	60.0	0.97		0.29	3.2
Event-based development												
Homeowner	1.04		0.96	4.4	0.66	***	0.08	33.8	0.90		0.16	9.9
Married	0.68	***	0.07	32.0	0.43	***	0.05	57.3	0.48		0.09	51.0
Parent	0.80	*	0.07	20.4	0.71	**	0.08	29.1	0.93		0.14	7.1
Self-perceived development												
Age	1.08		0.06	8.0	1.09		0.07	8.6	1.05		0.10	5.2
Maturity	1.14	*	0.06	14.2	1.23	+	0.07	23.0	1.12		0.10	11.9
Responsibility	0.94		0.05	6.1	0.95		0.06	4.8	1.08		0.11	7.6

Note. (+) p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001; RRR = Relative Risk Ration; SE = Standard Error; Δ% = Percent Change.

Participants in the Matured-Out profile had lower odds of being married or being a parent, relative to the stable normal class by young adulthood. Matured-Out participants perceived themselves to be more mature than their same aged peers at young adulthood relative to the Stable Normative Profile.

Figure 4.16

Predictor Variable Relative Risk Ratios for the Multinomial Regression Predicting Matured-Out Profile Membership Relative to the Stable Normative Profile Membership for Research Question 4

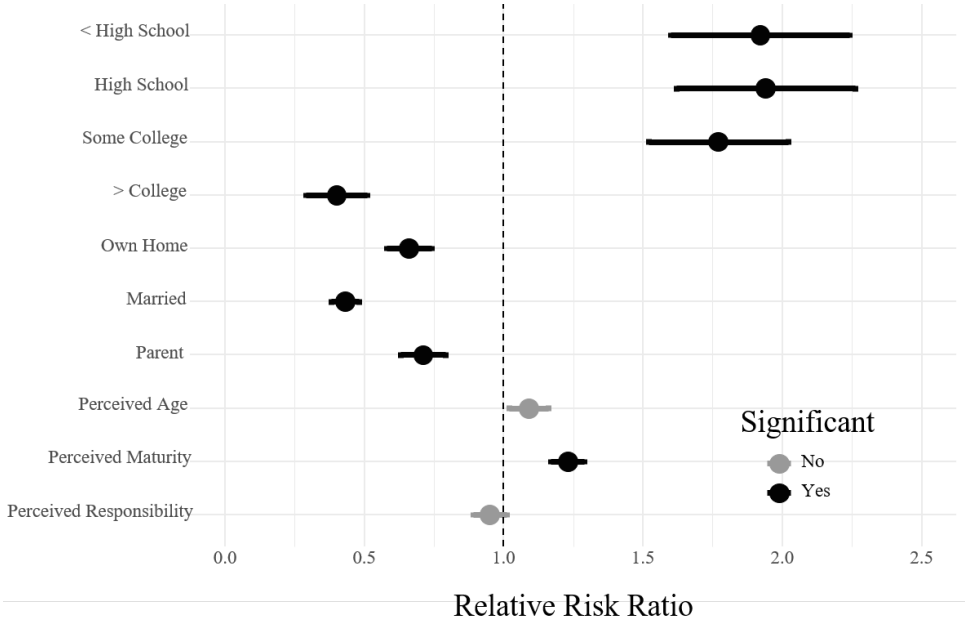


Predictors of Continuing-Cannabis

Roughly 7% of the Add Health sample terminated in the Continuing-Cannabis profile. The multinomial regression revealed several significant predictors for the Continuing-Cannabis profile of participants compared to the Stable Normative profile, see Figure 4.17. Participants in the Continuing-Cannabis profile completed less educational milestones than their peers in the Stable Normative profile. The odds of having less than a high school diploma or just a high school diploma was 91.5% and 93.8% higher than having a college degree. The odds of having some college, relative to a college degree, was 76.6% higher. Finally, the odds of having achieved greater than a college degree were 60% lower than having a college degree. This profile was educationally disadvantaged compared to the Stable Normative profile.

Figure 4.17

Predictor Variable Relative Risk Ratios for the Multinomial Regression Predicting Continuing-Cannabis Profile Membership Relative to Stable Normative Profile Membership for Research Question 4



Regarding event-based development, participants in the Continuing-Cannabis profile have significantly less odds of owning a home (RRR = 0.66), being married (RRR = 0.43), or being a parent (0.71). Participants in the Continuing-Cannabis profile also perceived themselves to be more mature than their peers compared to the Stable Normative profile.

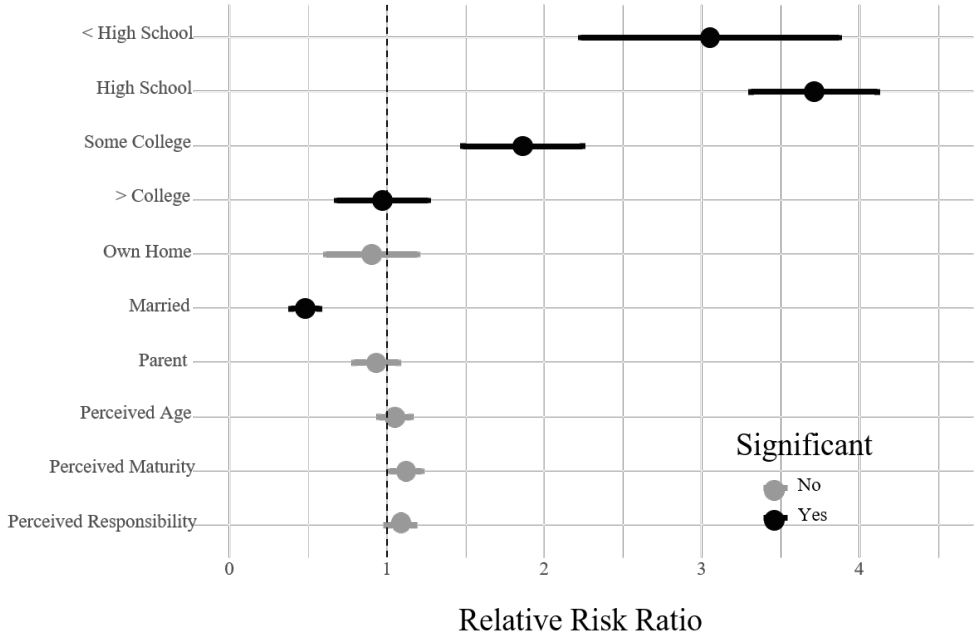
Predictors of Continuing-Illicit

The Continuing-Illicit profile was predicted by educational attainment predictor variables and marriage. Event-based indictors of home ownership and parenthood did not differ significantly from the Stable Normative profile. Self-perceived adulthood, also, did not differ significantly from the Stable Normative profile of participants. Continuing-

Illicit users were educationally disadvantaged compared to the Stable Normative profile. They had odds 204.7% greater of having less than a high school education and odds 271.1% times higher of only having a high school education compared to having a college degree, relative to the Stable Normative profile. For those who did take some post-high school training they had odds 86.3% higher of not completing their degree compared to completing their degree. Continuing Illicit users were also less likely to be married. The odds of participants in the Continuing-Illicit profile being married was 51.6% less than was seen in the Stable Normative profile. An illustration of these findings can be seen in Figure 4.18.

Figure 4.18

Predictor Variable Relative Risk Ratios for the Multinomial Regression Predicting Continuing-Illicit Profile Membership Relative to Stable Normative Profile Membership for Research Question 4



CHAPTER 5

DISCUSSION

The purpose of this study was to investigate changes in substance misuse across the transition to adulthood and how those changes were associated with young adult self-sufficiency, an important indicator of adult status in contemporary westernized societies (Arnett, 2000a). While there is mounting evidence of the negative short-term biological, education, and social consequences of substance misuse there is also substantial evidence that most individuals mature-out of substance misuse without notable difficulty, becoming well-functioning adults. These disparate trends were difficult to reconcile since research is still emerging on the long-term psychosocial outcomes of substance misuse during the transition to adulthood. This study considered how changing substance misuse patterns were associated with indicators of young adulthood.

Specific attention was given to terminal substance use classification, with a focus on two pressing terminal statuses: Matured-Out and Continuing-Cannabis groups. Matured-Out users experienced at least one period of substance misuse but terminated misuse by young adulthood. Continuing-Cannabis users experienced diverse substance use paths but continued to use cannabis regularly into young adulthood. Both groups have important practical and political implications. The insights derived from latent profile analyses, longitudinal mixture models, and mover-stayer analyses were discussed in the sections below.

Transitions in Substance across Development

The intent of Research Question 1 was to explore transitions in polysubstance use patterns across adolescence, emerging adulthood, and young adulthood. Four profiles of misuse emerged at each developmental period; however, the profiles did not remain constant at each development period. Instead, the underlying common patterns of substance misuse changed with time. Even the normative group, that was defined by low-to-no misuse, was better modeled with free parameters at each developmental period. This is indicative of changing relationships (instability) with substances as individuals age towards adulthood (Arnett, 1997). The changes align with expected epidemiological trends in substance use around these ages; lower normative misuse in adolescence, increased misuse in emerging adulthood, and reduced misuse in young adulthood (Schulenberg et al., 2019). It also lends support to research that shows young adults consuming alcohol more responsibly than emerging adults or adolescents (Masten et al., 2008).

Interestingly, the profiles identified in adolescence and emerging adulthood were similar in character; normative, alcohol and cannabis, low polysubstance, and high polysubstance profiles. While the normative and low polysubstance profiles remained in young adulthood, the alcohol and cannabis profile were not detected, nor was the high polysubstance use profile. Instead, two quantitatively unique profiles emerged during young adulthood. The two new profiles showed a strong preference for a single substance, either cannabis or an illicit substance. The changing of meaning of substance misuse latent profiles supports the life course notion of developmental discontinuity (and

the theory of emerging adulthood statute of instability). Individuals' paths experience many points of discontinuity, this appears to be especially true for those passing through emerging adulthood (Arnett, 2000a).

The trend toward single substance dominated profiles in young adulthood has also been seen in cohort studies which indicate polysubstance use is more prevalent among the young (Hedden et al., 2010; Merrin, & Leadbeeter, 2018; Midanik et al., 2007; Quek et al., 2013).

This could indicate a preference for a specific type high. It could also be debated that the transition to a single substance reflects a more responsible use pattern, especially for the cannabis profile since current rhetoric surrounding cannabis suggests it is a healthy alternative to alcohol (Masten et al., 2008).

In addition, to changing profile patterns between developmental periods, there was also substantial movement between profiles across time. The highest stability was seen among the individuals in the normative profile. Stability in this group was high between adolescence and emerging adulthood, 86%, indicating substantial continuity among those with less risky patterns of substance use. This was contrary to expectations for this group. Another pattern that contradicted the hypotheses was seen in the proportion of individuals in riskier substance use profiles moving into the normative profile. Between 65% and 76% of individuals in the profiles defined by substance misuse moved into the normative profile in emerging adulthood. Profile stability was low (6 % to 11%) among the profiles defined my misuse between adolescence and emerging adulthood. These finding did not align with similar longitudinal mixture model analyses

that consider polysubstance use across time (Merrin et al., 2018; Tomczyk, et al., 2016).

Notably, Merrin et al. (2018) considered a 10-year, 6 wave cohort study that included individuals between the ages of 12 and 18 at baseline. Stabilities remained high, above 58%, between all waves and in all classes of substance use. Transitions between waves tended towards transitions to higher-risk latent classes. One distinguishing characteristic between studies likely contributed for the differences in outcomes, the conceptualization of time. The current study utilized an accelerated cohort design which transitioned the data from a wave-based design (like what was used in the Merrin et al. study) to a developmental period-based design. The strength of conceptualizing time by development instead of wave occasion allowed for analytic points to better capture age-related outcomes (Miyazaki & Raudenbush, 2000). The final timepoint in the Merrin et al. study included individuals between the ages of 22 and 28, this final timepoint spanned two unique developmental periods. Individuals that the age of 22 were likely at the peak of substance misuse and those who were 28 were likely to be at a decline (Arnett, 2000a; Schulenberg et al., 2019). The conceptualization of time likely influenced why, even at the final wave, there is still high stability in substance misuse patterns and transitions towards riskier substance use. The current study was able to more accurately capture the maturing-out process expected as individuals move into young adulthood.

Demographics Contributors to Profile Membership

During emerging adulthood and young adulthood, being male was predictive of patterns defined by more substance misuse. This was especially true during emerging

adulthood when males were twice as likely to belong to a polysubstance profile than females. These findings align with what research has already established regarding greater risk taking among males (Byrnes et al., 1999). It also supports data that depicts females taking on adult roles earlier than male peers (Norona et al., 2015). A quicker transition into adult roles would suggest that patterns of substance misuse would be incompatible with their life course trajectory (Elder & Caspri, 1989).

Family SES showed interesting trends in substance use profile membership across time. During adolescence, having a parent with a college degree was protective against substance misuse. In emerging adulthood, having a parent with a college education was positively associated with membership in the alcohol and cannabis profile. This may be associated with individuals' personal transition to higher education. Children of college graduates are more likely to attend university themselves (Bloome et al., 2018). College students have high rates of substance misuse (Slutske et al., 2004). These finding parallel results from MTF, which indicate that college-bound students were less likely to use in high school, consume substances at higher rates while in college, and then reduce substance misuse quickly following college (Schulenberg et al., 2019).

Finally, race was significantly associated with several substance use profiles across time. The association of race on substance use profile was complicated, with race at one developmental period appearing to be protective against misuse and at another being predictive of misuse. Even though the results were complicated they were congruent with current knowledge on the role of race in substance misuse. A study considering the trajectories of substance use by race across development found white

individuals experienced more change in substance misuse across time (Chen & Jacobson, 2012). Individuals who identified as white experienced greater increases in substance misuse between adolescence and emerging adulthood, and then, greater decreases in misuse between emerging adulthood and young adulthood. Individuals who identified as black had steadier rates of change and were more likely to continue cannabis use into their thirties compared to other racial groups. Another study that focused on racial differences in substance misuse patterns found delayed substance use among individuals who identified as Black compared to individuals who identified as White (Clark et al., 2013). These research studies parallel findings from the current research.

A surprising nonfinding from the presented analyses was the lack of a profile defined by excessive alcohol misuse. Research suggests that an estimated 25% of individuals who abuse alcohol will transition to alcohol dependence in their lifetime (Flórez-Salamancaet al., 2013). Instead, alcohol misuse use was relatively similar among all profiles defined by some substance misuse. This suggests that alcohol misuse should regularly be set within the context of polysubstance use (Anthony et al., 2016).

Self-Sufficiency and Substance Use Patterns

Research Question 2 explored the impact of substance use patterns on young adult self-sufficiency. The mover-stayer model included a Stable Normative group (79.3%), a Matured-Out group (8.1%), and a Continuing-User group (12.6%). Significant associations were seen by substance use pattern and indicators of self-sufficiency in young adulthood. Dimensions of personal autonomy, responsibility, and financial

independence varied by mover-stayer group.

It was expected that Matured-Out users would have similar self-sufficiency outcomes compared to individuals who maintained a Stable Normative profile across time. Matured-Out users had at least one developmental period where they endorsed substance misuse but matured-out by young adulthood. The expectation that Matured-Out individuals would have similar outcomes as those in the Stable Normative group was aligned with epidemiological trends that show high substance misuse during emerging adulthood and then reduced misuse by young adulthood (Schulenberg et al., 2019). It also aligns with the developmental idea that substance misuse during emerging adulthood is a developmentally limited risk that most individuals resolve independently (Chen & Kendel, 1995; Labouvie, 1996; Stall & Biernacki, 1986; Winick, 1962). For the self-sufficiency constructs considered here, Matured-Out users had similar outcomes to those in the Stable Normative group.

Matured-Out individuals were just as likely to feel a sense of mastery over their lives as compared to individuals in the Stable Normative group. Stress levels, independent living, and economic distress were also similar between the groups. These findings align with life course theory notions of on-time development. Since substance misuse is prevalent during the transition to adulthood, those engaging in misuse were on-time with their peers (Arnett, 2000b). In mixed methods study, Parker et al. (2002) found that emerging adults, in general, tolerated *sensible use* of recreational drugs. Sensible use, as constructed by the emerging adult participants, was dependent upon drug type, health and performance consequences, and frequency of use. Given the high level of tolerance

for substance use during emerging adulthood, it is possible that misusers were insulated from consequences that would otherwise exist in a less tolerant atmosphere. Young adult self-sufficiency variables did not differ between Stable Normative users and Matured-Out users, with one exception. The construct of personal responsibility, measured through criminality, showed significant differences between groups. The effect size of the difference was estimated to be small, yet the shift in the curve, as was shown in Figure 4.9, indicates a push towards more criminal behaviors for those who matured-out of substance misuse. This is especially interesting because behaviors associated with the buying and selling of drugs were excluded in the measure. Instead, the criminal measured behaviors were associated with theft, vandalism, trespassing, and violence.

Research on the desistance of criminal behaviors in young adulthood suggests that substance misuse can increase accessibility to criminal opportunities (Hussong et al., 2004; Moffit, 1993). Criminal behaviors reflect "snares" that exist in the landscape of substance misuse. As matured-out individuals transition away from substance misuse, some of the snares that make substance misuse and criminality co-occur may still exist. Matured-out individuals may still have social ties that prolong criminal behaviors into young adulthood. Stable Normative users, on the other hand, may have fewer connections that could snare them in criminal behavior.

Differences in criminality between Stable Normative users and Continuing-Illicit users also support the notion of snares (Moffit, 1993). Individuals in the Continuing-Users groups engaged in criminal behaviors at a rate 5.9 times higher than that was seem among individuals in the Stable Normative population. Criminologists interested in crime

desistence often consider the role of ensnaring factors in delaying the transition to productive adult roles. Examining parolees' social landscape for possible snares offers points of intervention to speed desistence (Piquero et al., 2006). Most of the work looking at snares utilizes individuals who have been caught up in the justice system. This requires that individuals be caught, convicted, and released on parole. The participants followed in this research have the benefit of being from the general population. Their delinquent behaviors were, instead, self-reported, which carries its own bias (Babinski et al., 2001), but remains generalizable. The finding from the Add Health data suggests substance use and criminality continue to run together into young adulthood, even among populations that were not explicitly involved in the criminal justice system. Future research could consider pathways to study ensnaring factors in the general public during the transition to adulthood. A better understanding of these factors could assist matured-out and Continuing-Users by mitigating the negative consequences of antisocial and criminal behaviors. Continuing-Users varied on most constructs of young adult self-sufficiency from Stable Normative individuals. In addition to the higher rates of criminality mentioned above, Continuing-Users also perceived less personal mastery, more stress, and greater economic distress than their Stable Normative peers.

Personal mastery and stress were considered together as elements of young adult autonomy. Personal mastery reflected a sense of control over one's life, it encompassed a sense of autonomy in decision-making (Arnett, 1997, 2000a). Stress is a normal response to everyday pressures. Stress triggers psychological and physical reactions that can influence the way individuals behave (Pearlin et al., 1981). Healthy responses to stress

can result in growth and productivity (Smyth et al., 2018). Unhealthy responses to stress can result in psychological distress, mental health disorders, and ill health. Building the skills necessary to respond to everyday pressures is an important task during the transition to adulthood (Arnett, 1998). Interestingly, personal mastery and stress regularly intersect. Personal mastery has been found to mediate anxiety and stress in the face of stressful life events. Those with lower personal mastery had higher rates of distress in response to common, stressful life events (Pearlin et al., 1981). The findings in the current research, align with what might be expected for Continuing-Users. Research suggests that personal mastery is lower among substance users (Haider et a., 2020; Lassi et al., 2019). Furthermore, a common response to life stresses among addicts is increased use (for a review see Sinha, 2001).

Individuals in the Continuing-Users group were also less likely to feel a sense of financial independence that defines adulthood. The nature of substance abuse disorders may account for some economic distress. One indicator of a substance use disorder is neglecting other parts of one's life, like work, because of substance misuse (Hasin et al, 2013). Working while intoxicated was estimated to cost companies in the U.S. roughly $100 billion a year in accidents, lost productivity, and other problems (National Clearinghouse for Alcohol and Drug Information, n.d.). Unfortunately, substance abuse on-the-job is not uncommon. Substance misuse among the unemployed is also problematic. According to the Personal Responsibility and Work Opportunity Reconciliation Act of 1996, welfare recipients in many states were drug-tested as an eligibility requirement for public welfare assistance. To the extent the individuals in the

Continuing-Users group experience substance abuse or dependence tendencies, substance misuse could hinder their ability to experience regular financial independence.

An important element of Research Question 2 was to understand if substance misuse during the transition to adulthood was a developmentally limited risk factor. The data provides some evidence for this. Among the Matured-Out users, individuals seem to have acquired similar levels of adult self-sufficiency as their peers in the Stable Normative group, except for being involved in more criminality. On the other hand, Continuing-Users experienced deficits in their adulting capacities at young adulthood. This finding suggests that the ability, or inability, to smoothly transition out of substance misuse is complicated and considering misuse across the transition to adulthood as merely a developmentally limited risk factor is not true for all individuals (Sussman & Arnett, 2014).

Self-Sufficiency Among Continuing-Cannabis Users

Research Question 3 extended Research Question 2 by separating out Continuing-Cannabis Users from Continuing-Illicit Users. This is a timely research avenue as cannabis has been legalized for recreational uses in many states in the U.S. Despite restrictions as an illegal, Schedule 1 substance, cannabis remains the most widely used illicit substance among Americans. In recent legalization debates, the veracity of the Schedule 1 classification for cannabis has been called into question (Miller, 2013). The disparity in cannabis related arrests and imprisonments by socioeconomic status and race have also fueled debates to loosen these restrictions (Koch et al., 2016). Yet, research on

the long-term impacts of cannabis use were still unclear, especially the psychosocial impacts (Cerdá et al., 2012).

Research Question 3 further parsed out the variance in the model associated with Continued-Cannabis Users and Continuing-Illicit Users. Compared to the Stable Normative group, Continuing-Cannabis and Continuing-Illicit Users showed lower levels of personal autonomy, personal responsibility, and financial independence.

Personal Autonomy

The construct of personal autonomy was measured through perceived personal mastery and stress. Personal mastery was not found to be different among mover-stayer classes after parsing out Continuing-Cannabis Users. Stress, on the other hand, was found to be significantly higher among Continuing-Cannabis Users. Contrary to popular perceptions surrounding cannabis users as less stressed, members in the Continuing-Cannabis Use group experienced significantly more stressed in the past month than their Stable Normative peers. Neuroscience research has identified how cannabis interactions with natural stress response pathways in the brain. Cannabinoids interact with the hypothalamic-pituitary-adrenal (HPA) axis, which controls stress response. In the presence of cannabinoids, the HPA axis provides fewer and less intense responses to stressful situations (Cornelius et al., 2010; Pahn et al., 2008). This results in individuals who were less capable of being stressed. Interestingly, however, stress and anxiety were among the most cited reasons for continued cannabis use (Hyman & Sinha, 2009). Given the impact of cannabinoids on the brain and the HPA axis, it is logical that a withdrawal symptom from cannabis is severe mood changes (i.e., increases in irritability,

nervousness, anxiety, aggression, and anger) in response to everyday stressors (American Psychiatric Association, 2013). Given that cannabinoid intoxication habituates chronic users to lower stress responses and that withdrawal from cannabis can produce intense stress responses, it is not surprising that stress perpetuates cannabis use (Levin et al., 2010). The constant ebb and flow of maintaining cannabinoid concentrations at a sufficient level for the desired dampened response to stress may contribute the high perceived stress among Continuing-Cannabis users.

Personal Responsibility

Personal responsibility, in the form of criminal behaviors, was also elevated among Continuing-Cannabis Users compared to their Stable Normative peers. Continuing-Cannabis Users committed crimes at a rate 6.65 times higher than the Stable Normative users.

Among Matured-Out users, the increased criminality was attributed to remnant snares in their social environment from past associations with substance misuse (Hussong et al., 2004; Moffit, 1993). Among Continuing Cannabis Users and Continuing-Illicit Users, those snares were still active and can entrap Continuing-Users. Referring back to Figure 4.13, it becomes clear that the Stable Normative group was starkly zero-inflated, while the curves for all other groups were still zero-inflated, they were much flatter. Continued criminality among substance users is among the talking points for many anti-prohibition drug campaigns. Making substances legal would mitigate snares that were associated with the organized crime currently control drug markets (Baum, 2016). The counterargument, however, is that a portion of the crime committed by substance users

were due to intoxication or addiction (Caulkins & Kleiman, 2014).

The decriminalization and recreational policy changes in Colorado and Washington formed a natural laboratory for examining changes in crime with increased access to cannabis. In a natural time-series quasi-experiment, Lu et al. (2019) compared crime rates in Colorado and Washington to states who had not yet legalized cannabis. Across the nation, the U.S. was experiencing decreased crime rates since 2000. The point when retail sales were initiated in 2014 was utilized as the critical point for the regression discontinuity. Property crimes in Colorado (put not Washington) increased when retail sales were initiated. Violent crime rates did not differ from the comparison trajectories. Additional research should continue to measure the impact of cannabis legalization on crime. As recreational cannabis economy mature, better conclusions can be made.

Financial Independence

The final element of young adult self-sufficiency considered here was financial independence. Continuing-Cannabis Users experienced setbacks in their financial independence compared to their Stable Normative peers. Continuing-Cannabis Users were less likely to live independently and more likely to have experienced an economic distress event in the past year.

These findings may seem to be misaligned with findings from Eisen et al. (2002) study on monozygotic twins. In the Eisen et al. study, one twin used cannabis heavily during adolescence and emerging adulthood and the other did not. Results found no significant SES differences between siblings. The Eisen et al. study better reflects the SES outcomes of individuals who matured-out of cannabis misuse and not the impact of

Continued-Cannabis use.

These findings also align with other longitudinal research that found less economic stability among cannabis users (Brook, Lee, Finch, Seltzer, & Brook, 2013; Fergusson & Boden, 2008). To untangle the association between cannabis use and economic problems, Cerdá et al. (2016) analyzed cohort study data that followed participants from age 3 to age 38. This robust analysis identified that chronic cannabis users were more likely to take a downward step from their childhood SES to a lower adult SES. This translates to chronic cannabis users achieving less professionally than their parents. Additionally, chronic cannabis users experienced more financial difficulties in the form of indebtedness and cashflow problems. Interestingly, a recent literature review identified economically stressful events perpetuate substance misuse (Nagelhout, Hummel, de Goeij, de Vries, Kaner, & Lemmens, 2017).

Taken together, this research suggests that continued cannabis use into young adulthood is not without setbacks. Individuals who continue to use cannabis were less likely to have reached the same young adult milestones of self-sufficiency in autonomy, personal responsibility, and financial independence as their Stable Normative peers. These findings have implications for the legalization discussions. Specifically, that continued cannabis use into young adulthood appears to carry some adverse psychosocial outcomes.

Cannabis lobbyists have often promoted cannabis by highlighting the ills of alcohol use. Cannabis is marketed as an alternative recreational substance (Guttmannova et al., 2016). Yet, the current study found substantial difference in young adult

psychosocial outcomes compared to normative young adults. Normative use, as discussed in this research should not be confused with non-use. While normative users did not use cannabis or illicit drugs regularly, the model only considered alcohol misuse, it did not include responsible alcohol use. MTF trends suggest that roughly 75% of adults, ages 30 to 60 have past month alcohol use (Schulenberg et al., 2019). The expectation among Stable Normative individuals should be some amount of alcohol use, but low levels of misuse. When the comparison is made between Stable Normative and Continuing-Cannabis groups, cannabis is not emerging as an equal substitute to alcohol. Instead, regular cannabis use is associated with stunted young adult self-sufficiency.

Predictors of Substance Use Pattern at Young Adulthood

Research Question 4 sought to understand predictors of young adult substance use patterns. Significant differences between Stable Normative users and other types of users were identified. Educational attainment, traditional milestones of adulthood, and self-perceived adult status each added significantly to the prediction model. Notably, educational attainment was higher among the Stable Normative group. The balance between educational attainment status was more stable for individuals who matured-out. Matured-out users were, however, more likely to have some college, without completing a degree. Continuing-Cannabis and Continuing-Illicit users were also more likely to have some college compared to the Stable Normative group. They were also more likely to belong to other lesser educational attainment groups (attaining a high school degree or less).

The decision to attend college can be made at many points across the life span, however, it is an on-time consideration for adolescents as they graduate from high school. This reflects a new trajectory that could act as a turning point for many individuals. Well-invested efforts in advanced education can compound to launch emerging adults into satisfying lives (Côté, 2002). Obtaining a 4-year degree is associated with increased personal earning (Abel & Deitz, 2014), higher life satisfaction (Oreopoulos & Salvanes, 2011), better job security (Trostel, 2015), and, even, improved personal health (Lochner, 2011). The benefits of higher education are also intergenerational, impacting family trajectories for decades to come (Bloome et al., 2018). Emerging adulthood is believed to be a sensitive developmental period for obtaining advanced education (Baumrind & Moselle, 1985; Wood et al. 2018). The impacts of substance misuse during this sensitive developmental period may mark a lost opportunity to the benefits associated with advanced education.

The trajectory that leads to higher education is not available to all individuals. Limitations often exist due to socioeconomic barriers but can also emerge from personal choice and ability. Data from Monitoring the Future revealed that significantly fewer adolescents who engaged in substance misuse during high school transitioned to higher education after high school (Patrick et al., 2016). Substance misuse while attending higher education has also been found to impact educational attainment. Research by Ho and Krishna (2016) identified that the association between substance misuse and college dropout is mediated through GPA. College students who misuse substances spend less time studying and skip more classes (Caldeira et al., 2008; Wolaver, 2002). This reduces

exposure to classroom learning and inhibits interactions with faculty and classmates. Substance misuse also effects student integration into university life (Clowdus, 2016). Student substance misuse interferes with participation in curricular, co-curricular, and extra-curricular opportunities (Arria et al., 2013). In other words, substance misuse can interfere with students' engagement in all the opportunities promised by higher education. Not surprisingly, students that engage in substance misuse have more interruptions in their enrollment and fail to graduate at higher rates than students who do not misuse substances (Arria et al., 2013).

The decision to leave higher education reflects a second turning point. While individuals with some college education tend to earn more than individuals who have no college education, there are ripple effects to college drop out. Individuals with some college have less job security and are less qualified for jobs of the future (Arria et al., 2013). Over their lifetime, individuals with some college earn less than those with a degree. Given the high cost of college education, students who take out loans to pay for college and then drop-out are three times as likely to default on their loans, impacting their credit for years to come (Scott-Clayton, 2018).

It is difficult to discriminate between the direct and indirect effects of substance use on educational attainment and the direct and indirect effects of education attainment on substance use. Early substance misuse impacts educational pursuit. Substance misuse impacts educational performance and motivation. Yet, educational attainment impacts emerging adult and young adult substance use. Trends have found that while college-bound adolescents tended to misuse substances less in high school, they increased in

substance misuse at university (Schulenberg et al., 2019). White et al. (2005) showed that those transition to college had higher levels of misuse than non-college-bound peers. However, this increase appears to be a time-limited risk. With students who attended college reducing their substance misuse as they transitioned out of college and into young adulthood. Education, therefore, is an important protective factor as individuals transition to adult roles.

Importantly, the present research found that noncollege-bound adolescents are at greater risk of maintaining substance misuse patterns as they transition into adulthood. This group, while the most at risk, is also the hardest to reach in terms of providing support. While those attending college can be targeted on college campuses (in-person or virtually) for education and services, emerging adults not attending college are not easily found and are less motivated to participate in substance misuse prevention education. These findings support the idea that interventions should begin early to reach youth before they initiate substance use (Grant & Dawson, 1997; U.S. Department of Health and Human Services, 2016). Future research and policy should continue to identify opportunities to promote healthy substance use among use throughout emerging adulthood and young adulthood.

Event-based Markers of Adulthood

Traditionally, event-based transitions were utilized as indicators of adulthood. Theoretically, event-based markers serve as proxy variables for adulthood. Homeownership, marriage, and parenthood indicate the commitment to society, self, and family expected as individuals resolve the functional stage of identity formation.

Contemporarily, these transitions are considered less important indicators, instead favoring more intrinsic indicators. Yet, several of the event-based indicators of adulthood significantly contributed to the substance use patterns during the transition to adulthood. Home ownership, compared to the Stable Normative group, was lower among Continuing-Cannabis users only. Marriage was lower among matured-out, continuing cannabis, and continuing illicit substance use profiles. Parenthood was lower among matured-out and Continuing-Cannabis users, but not Continuing-Illicit users.

In a study exploring the long-term economic impacts of persistence cannabis use into early mid-adulthood (38-years of age) it was found that cannabis users experienced downward social-class mobility compared to their middle-class parents (Cerdá et al., 2016). The downward social-class shift may also account for a trend seen among an event-based, traditional milestone of adulthood, home ownership. Marriage and family variables also differed between substance use patterns in young adulthood. All groups, matured-out, continuing cannabis, and Continuing-Illicit users, were less likely to be married than individuals in the Stable Normative group. During the fourth data collection period of Add Health (2008) the national median age of first marriage was 26 for females and 28 for males. Given these central statistics and the defined age of young adults in this research, 26 to 34, marriage was an on-time behavior for these young adults. Yet, young adults who had participated in substance misuse were significantly less likely to have entered a marital union. Research from Willoughby, Hall, and Goff (2015) explored marriage centrality in emerging adult populations (i.e., how important emerging adults expected marriage to be in their adult lives). Marriage was esteemed as important, in fact,

it was believed, on average, to play a more important role than parenting, careers, or leisure on their adult lives. However, marriage centrality was significantly and inversely associated with substance misuse. This may explain why individuals in the latent mover-stayer profiles associated with substance misuse were less likely to be married, marriage may hold less intrinsic importance.

From a psychosocial lens, the lower rates of marriage may emerge because substance misuse during the critical developmental period of identity formation has slowed their ability to commit to an identity. Time spent engaged in risky behaviors diminished the time and energy available to explore options in work, love, and ideology (Baumrind & Moselle, 1985). A study exploring ego identity among emerging adults found that higher rates of substance misuse were associated with more role diffusion (Rose & Bond, 2009). Without the successful resolution of identity formation, entering into healthy intimate relationships is difficult (Erikson, 1961). The delay in marriage may result from a need to extend the process for identity formation before moving onto the next developmental stage.

Extensive research has found that marriage is adventitious. Married couples are healthier (Hughes & Waite, 2009; Waite & Lehrer, 2003), have more economic resources (Waite & Lehrer, 2003), and benefit from greater social support (Umberson et al., 2010). Yet, recent research exploring the now commonplace phenomenon of cohabitation advertises similar benefits (i.e., the benefits of marriage can be attributed to living with a partner). Results from this dissertation may not indicate that individuals in other groups are not in beneficial relationships that are providing them with similar health, economic,

and social benefits.

The final traditional, event-based characteristic considered in this research centered around parenthood. Parenthood was less likely among Matured-Out and Continuing-Cannabis users compared to the Stable Normative group. This is interesting as parenthood has been suggested to be a major turning point for substance recovery. Research by Dawson et al. (2006) explored the impact of transitional life events, like employment, marriage, and parenthood on maturing-out of substance misuse. The research considered individuals who met DSM-IV dependence criteria in the recent past. Among the considered life events, only parenthood emerged as having a direct influence on abstinence from substances. Parenthood strongly predicted recovery for both men and women at the 3-year postsurvey. Interestingly, parenthood was significantly less likely among individuals in the Matured-Out latent group. A major difference between the Dawson et al study and the current research is that participants in the current research did not meet substance abuse criteria and instead were classified by frequency of use. Many young adults will use substances heavily without meeting the criteria for abuse or addiction. This may account for the difference in findings.

Parenthood was not significantly different among those in the illicit substance use group. This is a disconcerting finding. Roughly 35% of the Stable Normative and Continuing-Illicit users were parents. Given the size of the Continuing-Illicit class (609 individuals), this reflects roughly 213 children with a parent regularly using illicit substances. Given that the Add Health data were designed to be nationally representative, this projection can be extended. In 2010, the U.S. Census counted nearly 26,000,000

people living in the U.S. between the ages of 26 and 34. Extending the proportion of Continuing-Illicit users (3.9%) from the current study to the U.S. population, there are about 1,000,000 Continuing-Illicit users based on 2010 data. If 35% of the Continuing-Illicit users are parents, as was seen in this study, there are 350,000 children who have an addict parent, conservatively assuming only one child per individual. This is problematic because the use of illicit substance, is often not conducive of responsible parenthood. As a result, children suffer. Children of addicts are more likely to exhibit behavioral problems (Molina et al., 2010), negative emotional control (Rafferty & Hartley, 2006), and poor social connectedness (Hinz, 1990). Additionally, children of addicts are more likely themselves to become addicts perpetuating intergenerational patterns (Yau et al., 2012). Substance policies should regularly consider impact on families as they seek to motivate healthy behaviors.

Self-Perceived Development

Delays in event-based indicators of adulthood, along with the diverse paths that result in adulthood have led researchers to seek more intrinsic indicators. Specifically, Add Health participants were asked to rate their self-perceived adult status compared to their peers. Participants compared their perceived age, maturity, and responsibility to their peers. Statistically significant differences were identified for the item that measured perceived maturity. Matured-out and Continuing-Cannabis users had a significantly higher relative rate ratio compared to the Stable Normative group. No differences in perceived age or responsibility were seen between groups.

Central statistics indicated that participants exhibited illusory superiority in their

self-perception of adult status. Illusory superiority explains that most humans believe they are better and more skilled than most other people (Sharot & Garrett, 2016). This can be a major barrier in research, as human participants overestimate their own skills relative to others. In the Add Health data roughly 60% of respondents endorsed being older, more mature, and more responsible than their peers.

Furthermore, the items were only moderately correlated (r between 0.34 and 0.43). Research by Benson and Elder (2011) used latent profile analysis to explore underlying heterogeneity in self-perceived adult status. Four unique profiles of adult status were seen. The findings support the notion that emerging and young adults today acquire adult-like responsibilities at different rates and via diverse paths (Côté, 2006).

In the research hypotheses it was expected that those who mature out of substance use may perceive themselves to be more adult because of successfully transitioning away from patterns of substance misuse. It was also expected that those still involved in misuse would perceive themselves as less adult. Participants in the Matured-Out class did perceive themselves as being more mature than peers compared to the Stable Normative class. On one hand, Matured-Out users could perceive themselves to be more mature based on their ability to overcome substance misuse behaviors. The choice to turning away from patterns of misuse provide opportunities for personal growth (Haroosh & Freedman, 2017). On the other hand, Matured-Out users could perceive themselves to be more mature based on comparison to their personal social networks. Social network analyses have revealed that individual substance use is associated with peer network substance use (Andrews, Tildesley, Hops, & Li, 2002). Individuals with strong valence to

peers who use substances are more likely to use substances themselves. Given that peer networks are important elements of substance misuse, it is likely that those who Matured-Out of substance use still have personal connections to individuals who remained in a profile defined by continuing misuse. As Matured-Out individuals consider their peers, they were likely comparing themselves to many peers who were still misusing substances and experiencing the less productive outcomes associated with continued use.

Interestingly, Continuing-Cannabis users also considered themselves to be significantly more mature than their peers. The possible explanations for greater perceived maturity stated above could also be true for the continuing cannabis user group, but there is less support based on the current findings. For example, the Continuing-Cannabis users group could see themselves as more mature if many of them had transitioned from heavier substance use earlier in development to only using cannabis in young adulthood. There is some evidence for this in the longitudinal mixture model. During adolescence and emerging adulthood, the class with higher cannabis use was also defined by heavier use of alcohol. Young adults in the continuing cannabis use group only use cannabis with high frequency. Given the recent rhetoric about cannabis as an alternative to alcohol, the pattern of regular cannabis use may reflect a responsible substance use pattern comparable to regular consumption of alcohol. However, results from this dissertation refutes this idea.

Research Question 1 revealed the main patterns of movement between substance use latent class to form the mover-stayer latent groups. Most individuals in the continuing cannabis use group arrive following periods of Stable Normative use (see Figure 4.11).

The major path that led to continuing cannabis use, then, illustrates a trend towards more substance use, not less.

The second explanation for more perceived maturity could be that individuals in the Matured-Out substance use category have social networks that include individuals who are less mature. Continuing-Cannabis users are more likely to have social networks that contain other substance users. By comparison, cannabis users may perceive themselves to be more mature. However, Research Questions 3 found that continuing cannabis and Continuing-Illicit users were both at a disadvantage when considering personal autonomy, personal responsibility, and financial independence variables. Given that both Continuing-User groups have poorer young adult self-sufficiency outcomes, it is also likely that the higher perceived maturity is an artifact of illusory superiority, a personal belief you are more skilled without evidence.

Future Directions and Limitations

Considered together, this dissertation added substantial insights to our understanding of substance misuse during the transition to adulthood in the general population. Findings suggest that there is substantial normative use across all developmental periods. Changes in substance use patterns favor movement towards normative use for most individuals. Individuals who engage in normative substance use by young adulthood, either Stable Normative or Matured-Out users, have similar young adult self-sufficiency outcome. Those who do not transition to a normative pattern are less self-sufficient.

Interestingly, when Continuing-Cannabis and Continuing-Illicit users were separated, disadvantage was found in both groups. This finding suggests that cannabis may not be simply and alternative recreational substance comparable (or better) than alcohol. Instead, Continuing-Cannabis users experienced lower levels of self-sufficiency compared to Stable Normative peers.

The changing topography of drug policy in the U.S. necessitates that this research be extended to populations where cannabis is now legal for recreational use. A weakness of this study is that the outcomes could be an artifact of a period effect. That, because the research was conducted during a period when cannabis use was more strictly regulated, findings will not extend to a society with loser policies. It is possible that many of the adverse young adult outcomes seen in this research are byproducts of cannabis illegality (O'Rand, 2001). In a society where cannabis can be freely used, individuals may enjoy greater access to resources that allow them to experience greater financial independence and more personal responsibility. Considering the biological effects of cannabis on the brain, perceived stress may likely be unchanged. Knowing the powerful impact of historical forces on life trajectories, additional research should continue to explore the psychosocial impacts of substance misuse as policy changes.

Important developmental patterns in substance misuse were identified in the research. Priority should be given to robust longitudinal studies to deepen collective understanding of the life course impacts of substance misuse. Research should continue to incorporate developmental stage-based designs over survey occasion-based designed to better account for the extreme differences seen between emerging adult and young

adult populations. As more longitudinal and life course studies are planned, survey questions should also strive to more robustly cover important topics. For example, the current study considered substance misuse across the past year, yet measurement occasions were spaced roughly 5 years apart. This gap in time and question coverage lead to holes in substance misuse trajectories. It is likely that many of the individuals classified in the Stable Normative group actually Matured-Out, but that the survey occasions did not align with a period of substance misuse. Detail to studies designed for longitudinal and developmental purposes should ensure that questions are inclusive.

Another avenue for continued research would be to robustly explore difference between individuals who are able to mature out and those who maintain patterns of substance misuse into young adulthood. The juxtaposition of experienced young adult self-sufficiency outcomes between Continuing-Illicit, Continuing-Cannabis, and Matured-Out users merits further exploration. To the extent that early childhood or adolescence variables can be used to predict young adult substance use status, more targeted intervention can be used to support transitions to healthy young adult lifestyles and the successful acquisition of adult traits.

Finally, additional research is necessary to establish the methods outlined for complexed mover-stayer models proposed in this dissertation. It was beyond the scope of the current project to robustly test and develop these methods through simulations. Next steps should include testing the MS steps with vary number of classes and transitions. Profile separation and transition probability should be among the varied simulations to identify limits of the proposed process. In general, more work is needed to establish

absolute and comparative fit indices for longitudinal mixture models. Developing standards and methods for ensuring good fit will increase confidence and usefulness of LLM and MS models.

Policy Implications

Currently, research is underpowered to sufficiently guide substance policy decisions (Meier et al., 2018; Mokrysz & Freeman, 2018; Volkow et al., 2014). This is in part due to the powerful social and political forces pushing policy, each group can find research evidence that support their position for or against legalization. What is clear, however, is that the impacts of substance misuse are complex. While this research is not without limitations, it points to significant difficulties for individuals who do not adopt normative substance use patterns by young adulthood. In spite of the short comings, policymakers should consider the impacts of short- and long-term consequence to both physical and psychosocial wellbeing associated with increased access and acceptability of cannabis (or other substances as debates emerge) in the general population. Plans should be made to educate individuals on the possible harms including the possibility of decreased personal autonomy, person responsibility, and financial independence. Public health safety nets should also be prepared to meet new demands of contemporary drug policies. Pulling from the results from this research, those safety nets should include increased access to addiction recovery supports, financial resources, opportunities for adult learners in higher education, and counseling services.

The intent of this dissertation was not to take a stance on legalization debates.

Instead, it sought to explore the impacts of maturing-out of substance misuse on young adult outcomes. The results indicated that individuals who mature-out were able to remain on-time with their normative using peers. Continuing-Cannabis and Continuing-Illicit users were not able to stay on-time with their peers in terms of young adult self-sufficiency outcomes. These findings highlight the need for more tracking and research in the scientific community and strong consideration among policymakers. If Continuing-Cannabis users are not equal to their Stable Normative peers what does that mean for policy? What further considerations must be made to support public health in a community where cannabis remains illegal?

What supports are necessary in communities were cannabis is or will become legal? These answers will best be defined as public health, community leaders, researchers, and policymakers come together for the good of the community.

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APPENDICES

Appendix A

Mplus Syntax for Latent Profile Analysis Class Enumeration

(STEP 1 OF THE 3 STEP APPROACH)

TITLE: LPA 4 PROFILE MODEL (example in adolescence)

```
DATA: FILE = AccCohort.dat;
VARIABLE: NAMES = AID drunk_a mari_a drug_a weights_I_IV;
IDVARIABLE = AID;
WEIGHT = weights_I_IV;
MISSING = all (-999);
USEVARIABLES = drunk_a mari_a drug_a;
Classes = C(4); ! specify # of latent classes

ANALYSIS: type = mixture;
          Estimator = MLR;
MODEL:    %OVERALL%
          [drunk_a* mari_a* drug_a*];
OUTPUT:     stdyx TECH11;
PLOT:     TYPE = PLOT3;
```

Appendix B

Mplus Syntax for Ordered Latent Profile Analysis

ORDERED MPLUS SYNTAX WHICH PROVIDED THE

TITLE: ORDERED LPA 4 PROFILE MODEL (example in adolescence)

```
DATA: FILE = AccCohort.dat;
VARIABLE: NAMES = AID drunk_a mari_a drug_a weights_I_IV;
IDVARIABLE = AID;
WEIGHT = weights_I_IV;
MISSING = all (-999);
USEVARIABLES = drunk_a mari_a drug_a;
Classes = C(4); ! specify # of latent classes

ANALYSIS: type = mixture;
          Estimator = MLR;
MODEL:    %OVERALL%
          [drunk_a* mari_a* drug_a*];
          %c#1% !alcohol & cannabis
          [drunk_a*1.756];
          [mari_a*1.847];
          [drug_a*0.967];

          %c#2% !low-polysubstance
          [drunk_a*2.545];
          [mari_a*2.507];
          [drug_a*2.316];

          %c#3% !high-polysubstance
          [drunk_a*2.899];
          [mari_a*4.33];
          [drug_a*5.103];

          %c#4% !normative
          [drunk_a*0.606];
          [mari_a*0.34];
          [drug_a*0.013];
OUTPUT:     stdyx TECH11;
PLOT:     TYPE = PLOT3;
```

Appendix C

Mplus Syntax for Ordered and Corrected Latent Profile Analysis

ORDERED & CORRECTED MPLUS SYNTAX (STEP-3 OF THE LPA 3-STEP APPROACH)

TITLE: ORDERED LPA 4 PROFILE MODEL (example in adolescence)

```
          DATA: FILE = AccCohort with probabilities.dat;
          VARIABLE: NAMES = drunk_a mari_a drug_a
                            CPROB1 CPROB2 CPROB3 CPROB4
                            Ca AID weights_I_IV;
          IDVARIABLE = AID;
          WEIGHT = weights_I_IV;
          MISSING = all (-999);
          USEVARIABLES = drunk_a mari_a drug_a;
          Classes = C(4); ! specify # of latent classes

ANALYSIS: type = mixture ;
                    Estimator = MLR;
          MODEL:
                    %c1#1% !alcohol & cannabis
                    [Ca#1@5.364];
                    [Ca#2@-.626];
                    [Ca#3@-1.757];

                    %c1#2% !low polysubstance
                    [Ca#1@-1.094];
                    [Ca#2@6.052];
                    [Ca#3@.799];

                    %c1#3% !high polysubstance
                    [Ca#1@.256];
                    [Ca#2@2.175];
                    [Ca#3@6.836];

                    %c1#4% !normative
                    [Ca#1@-11.864];
                    [Ca#2@-8.963];
                    [Ca#3@-11.335];
```

Appendix D

Mplus Syntax for Latent Mixture Model (LMM) with Covariates for Answering Research Question 1

MPLUS SYNTAX FOR LATENT MIXTURE MODEL (LMM) WITH COVARIATES FOR ANSWERING RESEARCH QUESTION 1

TITLE: Latent Mixture Model joining latent profile analyses (LPA) from adolescence, emerging adulthood, and young adulthood.

```
DATA: FILE = AccCohort with probabilities from all developmental periods.dat;

VARIABLE: NAMES = Ca   Cea    Cya !most likely class membership
                  hs_les   hs  some_col    col !covariates
                  white black native asian other sex !covariates
                    AID weight;

                    MISSING = all (-999, 999);
                    nominal = ca cea cya;
                    USEVARIABLES =
                    ca cea cya
                    hs_les hs  some_col    col
                    white black native asian other MALE ;
                    Classes = C1(4) C2(4) C3(4); !# LPA per devel. period
                    IDVARIABLE = AID;
                    weight = weight;
            DEFINE:
            IF (sex eq 1) THEN MALE = 1; !define gender variable
            IF (sex eq 2) THEN MALE = 0;

            ANALYSIS: type = mixture ;
                      ALGORITHM=INTEGRATION;
                      ESTIMATOR = MLR;


            MODEL:
            %overall%
            c2 on c1;
            c3 on c2;
            c1 on MALE hs_les hs some_col col white black native asian other;
            c2 on MALE hs_les hs some_col col white black native asian other;
            c3 on MALE hs_les hs some_col col white black native asian other;
   Model C1:
                    %c1#1% !alcohol & cannabis profile during adolescence
                      [Ca#1@5.364];
                      [Ca#2@-.626];
                      [Ca#3@-1.757];

                      %c1#2% !low polysubstance profile during adolescence
```

```
                    [Ca#1@-1.094];
                    [Ca#2@6.052];
                    [Ca#3@.799];

                    %c1#3% !high polysubstance profile during adolescence
                    [Ca#1@.256];
                    [Ca#2@2.175];
                    [Ca#3@6.836];

                    %c1#4% !normative profile during adolescence
                    [Ca#1@-11.864];
                    [Ca#2@-8.963];
                    [Ca#3@-11.335];
Model C2:
                   %c2#1%
                    [Cea#1@6.368];
                    [Cea#2@-7.446];
                    [Cea#3@-2.297];

                    %c2#2% !
                    [Cea#1@-.503];
                    [Cea#2@6.623];
                    [Cea#3@-.358];

                    %c2#3%
                    [Cea#1@-.704];
                    [Cea#2@-7.277];
                    [Cea#3@6.536];

                    %c2#4%
                    [Cea#1@-10.177];
                    [Cea#2@-13.815];
                    [Cea#3@-11.531];


Model C3:

                    %c3#1%
                    [cya#1@5.108];
                    [cya#2@-7.460];
                    [cya#3@-8.702];

                    %c3#2% !
                    [cya#1@-.333];
                    [cya#2@5.249];
```

```
[cya#3@-8.557];

%c3#3%
[cya#1@4.270];
[cya#2@-.619];
[cya#3@13.196];

%c3#4%
[cya#1@-6.438];
[cya#2@-13.814];
[cya#3@-13.814];
```

Appendix E

Mplus Syntax for Estimating a Mover-Stayer Model with 3-Time Points Use the Probability Parameterization without Distal Outcomes

MPLUS SYNTAX FOR ESTIMATING A MOVER-STAYER MODEL WITH 3-TIME POINTS USING THE PROBABILITY PARAMETERIZATION WITH-OUT DISTAL OUTCOMES

TITLE: Mover-Stayer Model with probability parameterization for modeling 3-profiles (Stable Normative, Matured-Out, and Continuing-Users)

```
DATA: FILE = AccCohort with probabilities all developmental periods low poly ref

VARIABLE: NAMES = Ca Cea Cya
                  weights_I_IV AID;

                  MISSING=all (-999, 999);
                  nominal = Ca Cea Cya;
                  USEVARIABLES = Ca Cea Cya;
                  WEIGHT = weights_I_IV;
                  Classes = M(3) C1(4) C2(4) C3(4); ! specify # of latent pro
                  IDVARIABLE = AID;

         ANALYSIS: type = mixture;
                  ALGORITHM=INTEGRATION;
                  ESTIMATOR = MLR;
                  Parameterization = PROBABILITY;

         MODEL:
!The code is low polysubstance referenced, this means the low polysubstance profi
!referred to in the syntax. The reference category may be meaningful for certain
!For this reason, the reference category should be selected meaningfully
%OVERALL%
           c2 on c1;
           c3 on c2;

  Model M:
   %M#1% !Matured-Out
     C2#1 on C1#1@.11; !alcohol/cannabis (adol.) on alcohol/cannabis (EA)
     C2#2 on C1#1@.76; !alcohol/cannabis (adol.) on normative (EA)
     C2#3 on C1#1@.08; !alcohol/cannabis (adol.) on high polysubstance (EA)

     C2#1 on C1#2@.21; !high poly (adol.) on alcohol/cannabis (EA)
     C2#2 on C1#2@.65; ! high poly (adol.) on normative (EA)
     C2#3 on C1#2@.08; ! high poly (adol.) on high poly (EA)

     C2#1 on C1#3@.60; !normative (adol.) on alcohol/cannabis (EA))
     C2#2 on C1#3@.00000001; ! normative (adol.) on normative (EA) near zero
     C2#3 on C1#3@.28; ! normative (adol.) on high poly (EA)
```

```
    C3#1 on C2#1@.00000001; !alcohol/cannabis (EA) on cannabis (YA)
    C3#2 on C2#1@.99999997; !alcohol/cannabis (EA) on normative (YA)
    C3#3 on C2#1@.00000001; !alcohol & cannabis (EA) on high illicit (YA)

!etc.

    C3#1 on C2#2@.00000001;
    C3#2 on C2#2@.99999997;
    C3#3 on C2#2@.00000001;

    C3#1 on C2#3@.00000001;
    C3#2 on C2#3@.99999997;
    C3#3 on C2#3@.00000001;

  %M#2% !continuing-users
    C2#1 on C1#1@.11;
    C2#2 on C1#1@.08;
    C2#3 on C1#1@.76;

    C2#1 on C1#2@.13;
    C2#2 on C1#2@.11;
    C2#3 on C1#2@.65;

    C2#1 on C1#3@.08;
    C2#2 on C1#3@.04;
    C2#3 on C1#3@.86;

    C3#1 on C2#1@.62;
    C3#2 on C2#1@.20;
    C3#3 on C2#1@.00000001; !near zero

    C3#1 on C2#2@.61;
    C3#2 on C2#2@.17;
    C3#3 on C2#2@.00000001; !near zero

    C3#1 on C2#3@.70;
    C3#2 on C2#3@.13;
    C3#3 on C2#3@.00000001;

  %M#3% !stable normative

    C2#1 on C1#1@.01;
    C2#2 on C1#1@.00001;
    C2#3 on C1#1@.01;
```

```
  C2#1 on C1#2@.00000001;
  C2#2 on C1#2@.99999997; !near one
  C2#3  on C1#2@.00000001;

  C2#1 on C1#3@.01; !0
  C2#2 on C1#3@.00001;
  C2#3  onC1#3@.01;

  C3#1  on  C2#1@.01;
  C3#2 on C2#1@.00001;
  C3#3  onC2#1@.01;

  C3#1 on C2#2@.00000001;
  C3#2 on C2#2@.99999997;
  C3#3 on C2#2@.00000001;

  C3#1  on  C2#3@.01;
  C3#2 on C2#3@.00001;
  C3#3  onC2#3@.01;

Model M.C1:

  %M#1.C1#1% !alcohol & cannabis (adolescence)
               [Ca#1@5.989];
               [Ca#2@6.26];
               [Ca#3@-1.131];

  %M#1.C1#2% !normative (adolescence)
               [Ca#1@-2.901];
               [Ca#2@8.963];
               [Ca#3@-2.372];

  %M#1.C1#3% !high polysubstance (adolescence)
               [Ca#1@-1.919];
               [Ca#2@-2.175];
               [Ca#3@4.661];


  %M#1.C1#4% !low polysubstance (adolescence)
               [Ca#1@-7.146];
               [Ca#2@-6.052];
               [Ca#3@-5.253];

  %M#2.C1#1% !alcohol and cannabis (adolescence)
```

```
                [Ca#1@5.989];
                [Ca#2@6.26];
                [Ca#3@-1.131];

  %M#2.C1#2% !normative (adolescence)
                [Ca#1@-2.901];
                [Ca#2@8.963];
                [Ca#3@-2.372];
  %M#2.C1#3% !high polysubstance (adolescence)
                [Ca#1@-1.919];
                [Ca#2@-2.175];
                [Ca#3@4.661];

  %M#2.C1#4% !low polysubstance (adolescence)
                [Ca#1@-7.146];
                [Ca#2@-6.052];
                [Ca#3@-5.253];

  %M#3.C1#1% !alcohol & cannabis (adolescence)

                [Ca#1@5.989];
                [Ca#2@6.26];
                [Ca#3@-1.131];

  %M#3.C1#2% !normative (adolescence)
                [Ca#1@-2.901];
                [Ca#2@8.963];
                [Ca#3@-2.372];

  %M#3.C1#3% !high polysubstance (adolescence)
                [Ca#1@-1.919];
                [Ca#2@-2.175];
                [Ca#3@4.661];

  %M#3.C1#4% !low polysubstance (adolescence)
                [Ca#1@-7.146];
                [Ca#2@-6.052];
                [Ca#3@-5.253];

Model M.C2:

  %M#1.c2#1% !alcohol & cannabis (emerging adulthood)
                [Cea#1@8.665];
                [Cea#2@2.297];
                [Cea#3@-5.149];
```

```
%M#1.c2#2% !normative (emerging adulthood)
              [Cea#1@1.354];
              [Cea#2@11.531];
              [Cea#3@-2.284];

%M#1.c2#3% !high polysubstance (emerging adulthood)
              [Cea#1@-0.145];
              [Cea#2@0.358];
              [Cea#3@6.980];

%M#1.c2#4% !low polysubstance (emerging adulthood)
              [Cea#1@-7.241];
              [Cea#2@-6.536];
              [Cea#3@-13.813];

%M#2.c2#1% !alcohol & cannabis (emerging adulthood)
              [Cea#1@8.665];
              [Cea#2@2.297];
              [Cea#3@-5.149];

%M#2.c2#2% !normative (emerging adulthood)
              [Cea#1@1.354];
              [Cea#2@11.531];
              [Cea#3@-2.284];

%M#2.c2#3% !high polysubstance (emerging adulthood)
              [Cea#1@-0.145];
              [Cea#2@0.358];
              [Cea#3@6.980];

%M#2.c2#4% !low polysubstance (emerging adulthood)
              [Cea#1@-7.241];
              [Cea#2@-6.536];
              [Cea#3@-13.813];

%M#3.c2#1% !alcohol & cannabis (emerging adulthood)
              [Cea#1@8.665];
              [Cea#2@2.297];
              [Cea#3@-5.149];

%M#3.c2#2% !normative (emerging adulthood)
              [Cea#1@1.354];
              [Cea#2@11.531];
              [Cea#3@-2.284];
```

```
    %M#3.c2#3% !high polysubstance (emerging adulthood)
                  [Cea#1@-0.145];
                  [Cea#2@0.358];
                  [Cea#3@6.980];

    %M#3.c2#4% !low polysubstance (emerging adulthood)
                  [Cea#1@-7.241];
                  [Cea#2@-6.536];
                  [Cea#3@-13.813];

Model M.C3:

    %M#1.c3#1% !cannabis (young adulthood)
                  [cya#1@12.568];
                  [cya#2@7.460];
                  [cya#3@-1.242];

    %M#1.c3#2% !normative (young adulthood)
                  [cya#1@7.375];
                  [cya#2@13.814];
                  [cya#3@0.0001];

    %M#1.c3#3% !high illicit (young adulthood)
                  [cya#1@4.889];
                  [cya#2@0.619];
                  [cya#3@13.815];

    %M#1.c3#4% !low polysubstance (young adulthood)
                  [cya#1@-5.582];
                  [cya#2@-5.249];
                  [cya#3@-13.807];

    %M#2.c3#1% !cannabis (young adulthood)
                  [cya#1@12.568];
                  [cya#2@7.460];
                  [cya#3@-1.242];

    %M#2.c3#2% !normative (young adulthood)
                  [cya#1@7.375];
                  [cya#2@13.814];
                  [cya#3@0.0001];

    %M#2.c3#3% !high illicit (young adulthood)
```

```
                    [cya#1@4.889];
                    [cya#2@0.619];
                    [cya#3@13.815];

    %M#2.c3#4% !low polysubstance (young adulthood)
                    [cya#1@-5.582];
                    [cya#2@-5.249];
                    [cya#3@-13.807];

    %M#3.c3#1% !cannabis (young adulthood)
                    [cya#1@12.568];
                    [cya#2@7.460];
                    [cya#3@-1.242];

    %M#3.c3#2% !normative (young adulthood)
                    [cya#1@7.375];
                    [cya#2@13.814];
                    [cya#3@0.0001];

    %M#3.c3#3% !high illicit (young adulthood)
                    [cya#1@4.889];
                    [cya#2@0.619];
                    [cya#3@13.815];

    %M#3.c3#4% !low polysubstance (young adulthood)
                    [cya#1@-5.582];
                    [cya#2@-5.249];
                    [cya#3@-13.807];

OUTPUT:   patterns TECH15  SVALUES;
SAVEDATA: file is MOVER STAYER 3 profile.dat;
          save = cprob;
          missflag = 999;
```

Appendix F

Mplus Syntax for Estimating a Mover-Stayer Model with 3-Time Points Using the Logit Parameterization without Distal Outcomes: Base Model

MPLUS SYNTAX FOR ESTIMATING A MOVER-STAYER MODEL WITH 3-TIME POINTS USING THE LOGIT PARAMETERIZATION WITHOUT DISTAL BASE MODEL

TITLE: Mover-Stayer Model with LOGIT parameterization for modeling 3-profiles (Stable Normative, Matured-Out, and Continuing-Users) base model

```
  DATA: FILE = AccCohort with probabilities all developmental periods low poly ref

VARIABLE: NAMES = Ca Cea Cya
      weights_I_IV AID;

                    MISSING = all (-999, 999);
                    nominal = Ca Cea Cya;
                    USEVARIABLES = Ca Cea Cya;
                    WEIGHT = weights_I_IV;
                    Classes = M(3) C1(4) C2(4) C3(4); !# of latent profiles
                    IDVARIABLE = AID;

          ANALYSIS: type = mixture;
                    ALGORITHM=INTEGRATION;
                    ESTIMATOR = MLR;
                    Parameterization = LOGIT;

MODEL:
  %OVERALL%
C1 C2 C3 on M;
       Model M:


         %M#1%  !Continuing-Users
           C2#1 on C1#1@.90;
           C2#2 on C1#1@2.69;
           C2#3 on C1#1@.60;

           C2#1 on C1#2@1.49;
           C2#2 on C1#2@-16.38;
           C2#3 on C1#2@.81;

           C2#1 on C1#3@.23;
           C2#2 on C1#3@1.88;
           C2#3 on C1#3@-0.08;

           C3#1 on C2#1@0;
           C3#2 on C2#1@13.82;
```

```
  C3#3 onC2#1@0;

  C3#1 on C2#2@0;
  C3#2 on C2#2@13.82;
  C3#3 on C2#2@0;

  C3#1 on C2#3@0;
  C3#2 on C2#3@13.82;
  C3#3 on C2#3@0;

%M#2% !Matured-Out
  C2#1 on C1#1@0.9;
  C2#2on C1#1@2.69;
  C2#3 on C1#1@0.6;

  C2#1 onC1#2@1.49;
  C2#2 on C1#2@2.75;
  C2#3 on C1#2@0.81;

  C2#1 on C1#3@.23;
  C2#2 on C1#3@1.88;
  C2#3 on C1#3@-0.08;

  C3#1 on C2#1@1.28;
  C3#2 on C2#1@-16.66;
  C3#3 onC2#1@.18;

  C3#1 on C2#2@1.52;
  C3#2 on C2#2@-16.56;
  C3#3 on C2#2@-0.15;

  C3#1 on C2#3@0.91;
  C3#2 on C2#3@-16.95;
  C3#3 on C2#3@-0.05;

%M#3% !Stable Normative

  C2#1 on C1#1@0;
  C2#2 onC1#1@0;
  C2#3 onC1#1@0;

  C2#1 onC1#2@0;
  C2#2 on C1#2@13.81551;
  C2#3 on C1#2@0.000001;
```

```
    C2#1 on C1#3@0;
    C2#2 on C1#3@0;
    C2#3 on C1#3@0;

    C3#1 on C2#1@0;
    C3#2 on C2#1@0;
    C3#3 on C2#1@0;

    C3#1 on C2#2@0;
    C3#2 on C2#2@13.81551;
    C3#3 on C2#2@0;

    C3#1 on C2#3@0;
    C3#2 on C2#3@0;
    C3#3 on C2#3@0;

Model M.C1:

  %M#1.C1#1% !alcohol & cannabis (adolescence)
              [Ca#1@5.989];
              [Ca#2@6.26];
              [Ca#3@-1.131];

  %M#1.C1#2% !normative (adolescence)
              [Ca#1@-2.901];
              [Ca#2@8.963];
              [Ca#3@-2.372];

  %M#1.C1#3% !high polysubstance (adolescence)
              [Ca#1@-1.919];
              [Ca#2@-2.175];
              [Ca#3@4.661];

  %M#1.C1#4% !low polysubstance (adolescence)
              [Ca#1@-7.146];
              [Ca#2@-6.052];
              [Ca#3@-5.253];

  %M#2.C1#1% !alcohol & cannabis (adolescence)
              [Ca#1@5.989];
              [Ca#2@6.26];
              [Ca#3@-1.131];

  %M#2.C1#2% !normative (adolescence)
              [Ca#1@-2.901];
```

```
                [Ca#2@8.963];
                [Ca#3@-2.372];


  %M#2.C1#3% !high poly substance (adolescence)
                [Ca#1@-1.919];
                [Ca#2@-2.175];
                [Ca#3@4.661];

  %M#2.C1#4% !low polysubstance (adolescence)
                [Ca#1@-7.146];
                [Ca#2@-6.052];
                [Ca#3@-5.253];

  %M#3.C1#1% !alcohol & cannabis (adolescence)
                [Ca#1@5.989];
                [Ca#2@6.26];
                [Ca#3@-1.131];

  %M#3.C1#2% !normative (adolescence)
                [Ca#1@-2.901];
                [Ca#2@8.963];
                [Ca#3@-2.372];

  %M#3.C1#3% !high polysubstance (adolescence)
                [Ca#1@-1.919];
                [Ca#2@-2.175];
                [Ca#3@4.661];

  %M#3.C1#4% !low polysubstance (adolescence)
                [Ca#1@-7.146];
                [Ca#2@-6.052];
                [Ca#3@-5.253];

Model M.C2:

  %M#1.c2#1% !alcohol & cannabis (emerging adulthood)
                [Cea#1@8.665];
                [Cea#2@2.297];
                [Cea#3@-5.149];

  %M#1.c2#2% !normative (emerging adulthood)
                [Cea#1@1.354];
                [Cea#2@11.531];
                [Cea#3@-2.284];
```

```
%M#1.c2#3% !high polysubstance (emerging adulthood)
              [Cea#1@-0.145];
              [Cea#2@0.358];
              [Cea#3@6.980];

%M#1.c2#4% !low polysubstance (emerging adulthood)
              [Cea#1@-7.241];
              [Cea#2@-6.536];
              [Cea#3@-13.813];

%M#2.c2#1% !alcohol & cannabis (emerging adulthood)
              [Cea#1@8.665];
              [Cea#2@2.297];
              [Cea#3@-5.149];

%M#2.c2#2% !normative (emerging adulthood)
              [Cea#1@1.354];
              [Cea#2@11.531];
              [Cea#3@-2.284];

%M#2.c2#3% !high polysubstance (emerging adulthood)
              [Cea#1@-0.145];
              [Cea#2@0.358];
              [Cea#3@6.980];

%M#2.c2#4% !low polysubstance (emerging adulthood)
              [Cea#1@-7.241];
              [Cea#2@-6.536];
              [Cea#3@-13.813];

%M#3.c2#1% !alcohol & cannabis (emerging adulthood)
              [Cea#1@8.665];
              [Cea#2@2.297];
              [Cea#3@-5.149];

%M#3.c2#2% !normative (emerging adulthood)
              [Cea#1@1.354];
              [Cea#2@11.531];
              [Cea#3@-2.284];

%M#3.c2#3% !high polysubstance (emerging adulthood)
              [Cea#1@-0.145];
              [Cea#2@0.358];
              [Cea#3@6.980];
```

```
   %M#3.c2#4% !low polysubstance (emerging adulthood)
                [Cea#1@-7.241];
                [Cea#2@-6.536];
                [Cea#3@-13.813];

Model M.C3:

   %M#1.c3#1% !cannabis (young adulthood)
                [cya#1@12.568];
                [cya#2@7.460];
                [cya#3@-1.242];

   %M#1.c3#2% !normative (young adulthood)
                [cya#1@7.375];
                [cya#2@13.814];
                [cya#3@0.0001];

   %M#1.c3#3% !high illicit (young adulthood)
                [cya#1@4.889];
                [cya#2@0.619];
                [cya#3@13.815];

   %M#1.c3#4% !low polysubstance (young adulthood)
                [cya#1@-5.582];
                [cya#2@-5.249];
                [cya#3@-13.807];

   %M#2.c3#1% !cannabis (young adulthood)
                [cya#1@12.568];
                [cya#2@7.460];
                [cya#3@-1.242];

   %M#2.c3#2% !normative (young adulthood)
                [cya#1@7.375];
                [cya#2@13.814];
                [cya#3@0.0001];

   %M#2.c3#3% !high illicit (young adulthood)
                [cya#1@4.889];
                [cya#2@0.619];
                [cya#3@13.815];

   %M#2.c3#4% !low polysubstance (young adulthood)
                [cya#1@-5.582];
```

```
                [cya#2@-5.249];
                [cya#3@-13.807];

  %M#3.c3#1% !cannabis (young adulthood)
                [cya#1@12.568];
                [cya#2@7.460];
                [cya#3@-1.242];

  %M#3.c3#2% !normative (young adulthood)
                [cya#1@7.375];
                [cya#2@13.814];
                [cya#3@0.0001];

 %M#3.c3#3% !high illicit (young adulthood)
                [cya#1@4.889];
                [cya#2@0.619];
                [cya#3@13.815];

  %M#3.c3#4% !low polysubstance (young adulthood)
                [cya#1@-5.582];
                [cya#2@-5.249];
                [cya#3@-13.807];

SAVEDATA: file is 3444 MOVER STAYER base model.dat;
         save = cprob;
         missflag = 999;
```

Appendix G

Mplus Syntax for Estimating a Mover-Stayer Model with 3-Time Points Using the Logit Parameterization with Distal Outcomes: Adjusted Model for Answering Research Question 3

MPLUS SYNTAX FOR ESTIMATING A MOVER-STAYER MODEL WITH 3-TIME POINTS USING THE LOGIT PARAMETERIZATION WITH DISTAL OUTCOMES ADJUSTED MODEL FOR ANSWERING RESEARCH QUESTION 3

TITLE: Mover-Stayer Model with LOGIT parameterization for modeling 3-profiles (Stable Normative, Matured-Out, and Continuing-Users) adjusted model for answering Research Question 3

```
 DATA: FILE = AccCohort with probabilities all developmental periods low poly refe

VARIABLE: NAMES = Ca Cea Cya
      weights_I_IV AID
      liv_ind ecd4 stress
      parent house prec_age
      mature respons married crimin1;

                  MISSING = all (-999, 999);
                  nominal = Ca Cea Cya;
                  USEVARIABLES = Ca Cea Cya liv_ind;
                  WEIGHT = weights_I_IV;
                  Classes = M(3) C1(4) C2(4) C3(4); !# of latent profiles
                  IDVARIABLE = AID;

          ANALYSIS: type = mixture;
                    ALGORITHM=INTEGRATION;
                    ESTIMATOR = MLR;
                    Parameterization = LOGIT;
MODEL:
  %OVERALL%
            C1 C2 C3 on M;
  MODEL M:
     %M#1% !Matured-Out
         C2#1 on C1#1@1.279865;
         C2#2 on C1#1@2.598407;
         C2#3 on C1#1@.175891;

         C2#1 on C1#2@1.519826;
         C2#2 on C1#2@-18.4207;
         C2#3 on C1#2@-.15415;

         C2#1 on C1#3@.911836;
         C2#2 on C1#3@1.912009;
         C2#3 on C1#3@-.156;
```

```
    C3#1 on C2#1@0;
    C3#2 onC2#1@45;
    C3#3 onC2#1@0;

    C3#1 onC2#2@0;
    C3#2 onC2#2@45;
    C3#3 onC2#2@0;

    C3#1 onC2#3@0;
    C3#2 onC2#3@45;
    C3#3 onC2#3@0;

[liv_ind*] (m11);
liv_ind* (v11);

![ecd4] (m12);
!ecd4 (v12);

![stress] (m13);
!stress (v13);

![depress] (m14);
!depress (v14);

![mastery] (m15);
!mastery (v15);

![crimin1] (m16);
!crimin1 (v16);

%M#2% !Continuing-Users

    C2#1 on C1#1@1.279865;
    C2#2 on C1#1@2.598407;
    C2#3 onC1#1@.178591;

    C2#1 on C1#2@-2.65456;
    C2#2 on C1#2@-4.17439;
    C2#3 on C1#2@-4.32854;

    C2#1 onC1#3@.911836;
    C2#2 on C1#3@1.912009;
    C2#3 on C1#3@-0.156;

    C3#1 on C2#1@1.279865;
```

```
    C3#2 on C2#1@-16.6648;
    C3#3 on C2#1@0.175891;

    C3#1 on C2#2@1.519826;
    C3#2 on C2#2@-16.5599;
    C3#3 onC2#2@-.15415;

    C3#1 onC2#3@.911836;
    C3#2 on C2#3@-16.9518;
    C3#3 on C2#3@-.156;

[liv_ind*] (m21);
liv_ind* (v21);

![ecd4] (m12);
!ecd4 (v22);

![stress] (m23);
!stress (v23);

![depress] (m24);
!depress (v24);

![mastery] (m25);
!mastery (v25);

![crimin1] (m26);
!crimin1 (v26);

%M#3% !Stable Normative

    C2#1 on C1#1@1.279865;
    C2#2 on C1#1@-18.4207;
    C2#3 onC1#1@.175891;

    C2#1 on C1#2@0.000001;
    C2#2 on C1#2@13.81551;
    C2#3 on C1#2@0.000001;

    C2#1 onC1#3@.911836;
    C2#2 on C1#3@-18.4207;
    C2#3 on C1#3@-.156;

    C3#1 on C2#1@-6.90776;
    C3#2 on C2#1@-6.90776;
```

```
        C3#3 on C2#1@-6.90776;

        C3#1 on C2#2@0.000001;
        C3#2 on C2#2@13.81551;
        C3#3 on C2#2@0.000001;

        C3#1 on C2#3@-6.90776;
        C3#2 on C2#3@-6.90776;
        C3#3 on C2#3@-6.90776;

    [liv_ind*] (m31);
    liv_ind* (v31);

    ![ecd4] (m32);
    !ecd4 (v32);

    ![stress] (m33);
    !stress (v33);

    ![depress] (m34);
    !depress (v34);

    ![mastery] (m35);
    !mastery (v35);

    ![crimin1] (m36);
    !crimin1 (v36);

MODEL M.C1:
    %M#1.C1#1%
    [ ca#1@5.98900 ];
    [ ca#2@6.26000 ];
    [ ca#3@-1.13100 ];

    %M#1.C1#2%
    [ ca#1@-2.90100 ];
    [ ca#2@8.96300 ];
    [ ca#3@-2.37200 ];

    %M#1.C1#3%
    [ ca#1@-1.91900 ];
    [ ca#2@-2.17500 ];
    [ ca#3@4.66100 ];

    %M#1.C1#4%
```

```
    [ ca#1@-7.14600 ];
    [ ca#2@-6.05200 ];
    [ c
    mailto:ca%231@-7.14600

    %M#2.C1#1%
    [ ca#1@5.98900 ];
    [ ca#2@6.26000 ];
    [ ca#3@-1.13100 ];

    %M#2.C1#2%
    [ ca#1@-2.90100 ];
    [ ca#2@8.96300 ];
    [ ca#3@-2.37200 ];

    %M#2.C1#3%
    [ ca#1@-1.91900 ];
    [ ca#2@-2.17500 ];
    [ ca#3@4.66100 ];

    %M#2.C1#4%
    [ ca#1@-7.14600 ];
    [ ca#2@-6.05200 ];
    [ ca#3@-5.25300 ];

    %M#3.C1#1%
    [ ca#1@5.98900 ];
    [ ca#2@6.26000 ];
    [ ca#3@-1.13100 ];

    %M#3.C1#2%
    [ ca#1@-2.90100 ];
    [ ca#2@8.96300 ];
    [ ca#3@-2.37200 ];

    %M#3.C1#3%
    [ ca#1@-1.91900 ];
    [ ca#2@-2.17500 ];
    [ ca#3@4.66100 ];

    %M#3.C1#4%
    [ ca#1@-7.14600 ];
    [ ca#2@-6.05200 ];
    [ ca#3@-5.25300 ];

MODEL M.C2:
```

```
%M#1.C2#1%
[ cea#1@8.66500 ];
[ cea#2@2.29700 ];
[ cea#3@-5.14900 ];

%M#1.C2#2%
[ cea#1@1.35400 ];
[ cea#2@11.53100 ];
[ cea#3@-2.28400 ];

%M#1.C2#3%
[ cea#1@-0.14500 ];
[ cea#2@0.35800 ];
[ cea#3@6.98000 ];

%M#1.C2#4%
[ cea#1@-7.24100 ];
[ cea#2@-6.53600 ];
[ cea#3@-13.81300 ];

%M#2.C2#1%
[ cea#1@8.66500 ];
[ cea#2@2.29700 ];
[ cea#3@-5.14900 ];

%M#2.C2#2%
[ cea#1@1.35400 ];
[ cea#2@11.53100 ];
[ cea#3@-2.28400 ];

%M#2.C2#3%
[ cea#1@-0.14500 ];
[ cea#2@0.35800 ];
[ cea#3@6.98000 ];

%M#2.C2#4%
[ cea#1@-7.24100 ];
[ cea#2@-6.53600 ];
[ cea#3@-13.81300 ];

%M#3.C2#1%
[ cea#1@8.66500 ];
[ cea#2@2.29700 ];
[ cea#3@-5.14900 ];
```

```
    %M#3.C2#2%
    [ cea#1@1.35400 ];
    [ cea#2@11.53100 ];
    [ cea#3@-2.28400 ];

    %M#3.C2#3%\
    [ cea#1@-0.14500 ];
    [ cea#2@0.35800 ];
    [ cea#3@6.98000 ];

    %M#3.C2#4%
    [ cea#1@-7.24100 ];
    [ cea#2@-6.53600 ];
    [ cea#3@-13.81300 ];

MODEL M.C3:
    %M#1.C3#1%
    [ cya#1@12.56800 ];
    [ cya#2@7.46000 ];
    [ cya#3@-1.24200 ];

    %M#1.C3#2%
    [ cya#1@7.37500 ];
    [ cya#2@13.81400 ];
    [ cya#3@0.00010 ];

    %M#1.C3#3%
    [ cya#1@4.88900 ];
    [ cya#2@0.61900 ];
    [ cya#3@13.81500 ];

    %M#1.C3#4%
    [ cya#1@-5.58200 ];
    [ cya#2@-5.24900 ];
    [ cya#3@-13.80700 ];

    %M#2.C3#1%
    [ cya#1@12.56800 ];
    [ cya#2@7.46000 ];
    [ cya#3@-1.24200 ];

    %M#2.C3#2%
    [ cya#1@7.37500 ];
    [ cya#2@13.81400 ];
    [ cya#3@0.00010 ];
```

```
%M#2.C3#3%
[ cya#1@4.88900 ];
[ cya#2@0.61900 ];
[ cya#3@13.81500 ];

%M#2.C3#4%
[ cya#1@-5.58200 ];
[ cya#2@-5.24900 ];
[ cya#3@-13.80700 ];

%M#3.C3#1%
[ cya#1@12.56800 ];
[ cya#2@7.46000 ];
[ cya#3@-1.24200 ];

%M#3.C3#2%
[ cya#1@7.37500 ];
[ cya#2@13.81400 ];
[ cya#3@0.00010 ];

%M#3.C3#3%
[ cya#1@4.88900 ];
[ cya#2@0.61900 ];
[ cya#3@13.81500 ];

%M#3.C3#4%
[ cya#1@-5.58200 ];
[ cya#2@-5.24900 ];
[ cya#3@-13.80700 ];

SAVEDATA: file is 3444 MOVER STAYER adjusted model.dat;
          save = cprob;
          missflag = 999;
```

Appendix H

Mplus Syntax for Mover-Stayer Model with 3-Time Points Using the Logit Parameterization with Predictor Variables in Adjusted Model for Answering Research Question 4

MPLUS SYNTAX FOR MOVER-STAYER MODEL WITH 3-TIME POINTS USING THE LOGIT PARAMETERIZATION WITH PREDICTOR VARIABLES IN ADJUSTED MODEL FOR ANSWERING RESEARCH QUESTION 4

```
TITLE: Mover-Stayer Model with LOGIT parameterization for modeling 4-profiles
       (Stable Normative, Matured-Out, Continuing-Cannabis and Continuing-Illicit)
       adjusted model for answering Research Question 4

  DATA: FILE = AccCohort with probabilities all developmental periods low poly ref

 VARIABLE: NAMES = Ca Cea Cya
       weights_I_IV AID
       lesshs hs somecol colplus
       parent married house
       prec_age mature respons;

                     MISSING = all (-999, 999);
                     nominal = Ca Cea Cya;
                     USEVARIABLES = Ca Cea Cya
                   lesshs hs somecol colplus
                   parent married house
                   prec_age mature respons;

                     WEIGHT = weights_I_IV;
                     Classes = M(4) C1(4) C2(4) C3(4); !# of latent profiles
                     IDVARIABLE = AID;

           ANALYSIS: type = mixture;
                     ALGORITHM=INTEGRATION;
                     ESTIMATOR = MLR;
                     Parameterization = LOGIT;
 MODEL:
   %OVERALL%
               C1 C2 C3 on M;
 M on lesshs hs somecol colplus parent house prec_age mature respons married;

   MODEL M:
      %M#1% !Continuing-Cannabis
          C2#1 on C1#1@.90016135;
          C2#2 on C1#1@.816628245;
          C2#3 on C1#1@.598836501;

          C2#1 on C1#2@1.485823956;
          C2#2 on C1#2@1.190594675;
```

```
  C2#3 on C1#2@.813510863;

  C2#1 on C1#3@.232805462;
  C2#2 on C1#3@.310986763;
  C2#3 on C1#3@-.08058067;

  C3#1 on C2#1@45;
  C3#2 on C2#1@0.000001;
  C3#3 on C2#1@0.000001;

  C3#1 on C2#2@45;
  C3#2 on C2#2@0.000001;
  C3#3 on C2#2@0.000001;

  C3#1 on C2#3@45;
  C3#2 on C2#3@0.000001;
  C3#3 on C2#3@0.000001;

%M#2% !matured-out
  C2#1 on C1#1@.90016135;
  C2#2 on C1#1@2.689207113;
  C2#3 on C1#1@.598836501;

  C2#1 on C1#2@1.51938;
  C2#2 on C1#2@-16.11809565;
  C2#3 on C1#2@-.15415;

  C2#1 on C1#3@0.232805462;
  C2#2 on C1#3@1.875529352;
  C2#3 on C1#3@-.080852097;

  C3#1 on C2#1@0.000001;
  C3#2 on C2#1@45;
  C3#3 on C2#1@0.000001;

  C3#1 on C2#2@0.000001;
  C3#2 on C2#2@45;
  C3#3 on C2#2@0.000001;

  C3#1 on C2#3@0.000001;
  C3#2 on C2#3@45;
  C3#3 on C2#3@0.000001;

%M#3% !Continuing-Illicit
  C2#1 on C1#1@.90016135;
```

```
  C2#2 on C1#1@2.689207113;
  C2#3 on C1#1@.813510863;

  C2#1 on C1#2@1.485823956;
  C2#2 on C1#2@2.746077597;
  C2#3 on C1#2@.813510863;

  C2#1 on C1#3@.232805462;
  C2#2 on C1#3@1.875529352;
  C2#3 on C1#3@-.080852097;

  C3#1 on C2#1@-13.8155;
  C3#2 on C2#1@-13.8155;
  C3#3 on C2#1@.175891;

  C3#1 on C2#2@-13.8155;
  C3#2 on C2#2@-13.8155;
  C3#3 on C2#2@-.15415;

  C3#1 on C2#3@-13.8155;
  C3#2 on C2#3@-13.8155;
  C3#3 on C2#3@-.156004248;

%M#4% !stable normative
  C2#1 on C1#1@-18.42;
  C2#2 on C1#1@-18.42;
  C2#3 on C1#1@2.3;

  C2#1 on C1#2@0.000001;
  C2#2 on C1#2@13.81551;
  C2#3 on C1#2@0.000001;

  C2#1 on C1#3@2.3;
  C2#2 on C1#3@-18.42;
  C2#3 on C1#3@2.3;

  C3#1 on C2#1@2.3;
  C3#2 on C2#1@-18.42;
  C3#3 on C2#1@2.3;

  C3#1 on C2#2@0.000001;
  C3#2 on C2#2@13.81551;
  C3#3 on C2#2@0.000001;

  C3#1 on C2#3@2.3;
```

```
    C3#2 on C2#3@-18.42;
    C3#3 onC2#3@2.3;

Model M.C1:
  %M#1.C1#1% !alcohol & cannabis (adolescence)
                [Ca#1@5.989];
                [Ca#2@6.26];
                [Ca#3@-1.131];

  %M#1.C1#2% !normative (adolescence)
                [Ca#1@-2.901];
                [Ca#2@8.963];
                [Ca#3@-2.372];

  %M#1.C1#3% !high polysubstance (adolescence)
                [Ca#1@-1.919];
                [Ca#2@-2.175];
                [Ca#3@4.661];

  %M#1.C1#4% !low polysubstance (adolescence)
                [Ca#1@-7.146];
                [Ca#2@-6.052];
                [Ca#3@-5.253];

  %M#2.C1#1% !alcohol & cannabis (adolescence)
                [Ca#1@5.989];
                [Ca#2@6.26];
                [Ca#3@-1.131];

  %M#2.C1#2% !normative (adolescence)
                [Ca#1@-2.901];
                [Ca#2@8.963];
                [Ca#3@-2.372];

  %M#2.C1#3% !high polysubstance (adolescence)
                [Ca#1@-1.919];
                [Ca#2@-2.175];
                [Ca#3@4.661];

  %M#2.C1#4% !low polysubstance (adolescence)
                [Ca#1@-7.146];
                [Ca#2@-6.052];
                [Ca#3@-5.253];

  %M#3.C1#1% !alcohol & cannabis (adolescence)
```

```
                [Ca#1@5.989];
                [Ca#2@6.26];
                [Ca#3@-1.131];

   %M#3.C1#2% !normative (adolescence)
                [Ca#1@-2.901];
                [Ca#2@8.963];
                [Ca#3@-2.372];

   %M#3.C1#3% !high poly substance (adolescence)
                [Ca#1@-1.919];
                [Ca#2@-2.175];
                [Ca#3@4.661];

   %M#3.C1#4% !low polysubstance (adolescence)
                [Ca#1@-7.146];
                [Ca#2@-6.052];
                [Ca#3@-5.253];

   %M#4.C1#1% !alcohol & cannabis (adolescence)
                [Ca#1@5.989];
                [Ca#2@6.26];
                [Ca#3@-1.131];

   %M#4.C1#2% !normative (adolescence)
                [Ca#1@-2.901];
                [Ca#2@8.963];
                [Ca#3@-2.372];

   %M#4.C1#3% !high polysubstance (adolescence)
                [Ca#1@-1.919];
                [Ca#2@-2.175];
                [Ca#3@4.661];

   %M#4.C1#4% !low polysubstance (adolescence)
                [Ca#1@-7.146];
                [Ca#2@-6.052];
                [Ca#3@-5.253];

Model M.C2:
   %M#1.c2#1% !alcohol & cannabis (emerging adulthood)
                [Cea#1@8.665];
                [Cea#2@2.297];
                [Cea#3@-5.149];
```

```
%M#1.c2#2% !normative (emerging adulthood)
              [Cea#1@1.354];
              [Cea#2@11.531];
              [Cea#3@-2.284];


%M#1.c2#3% !high polysubstance (emerging adulthood)
              [Cea#1@-0.145];
              [Cea#2@0.358];
              [Cea#3@6.980];

%M#1.c2#4% !low polysubstance (emerging adulthood)
              [Cea#1@-7.241];
              [Cea#2@-6.536];
              [Cea#3@-13.813];

%M#2.c2#1% !alcohol & cannabis (emerging adulthood)
              [Cea#1@8.665];
              [Cea#2@2.297];
              [Cea#3@-5.149];

%M#2.c2#2% !normative (emerging adulthood)
              [Cea#1@1.354];
              [Cea#2@11.531];
              [Cea#3@-2.284];

%M#2.c2#3% !high polysubstance (emerging adulthood)
              [Cea#1@-0.145];
              [Cea#2@0.358];
              [Cea#3@6.980];

%M#2.c2#4% !low polysubstance (emerging adulthood)
              [Cea#1@-7.241];
              [Cea#2@-6.536];
              [Cea#3@-13.813];

%M#3.c2#1% !alcohol & cannabis (emerging adulthood)
              [Cea#1@8.665];
              [Cea#2@2.297];
              [Cea#3@-5.149];

%M#3.c2#2% !normative (emerging adulthood)
              [Cea#1@1.354];
              [Cea#2@11.531];
```

```
                [Cea#3@-2.284];

   %M#3.c2#3% !high polysubstance (emerging adulthood)
                [Cea#1@-0.145];
                [Cea#2@0.358];
                [Cea#3@6.980];

   %M#3.c2#4% !low polysubstance (emerging adulthood)
                [Cea#1@-7.241];
                [Cea#2@-6.536];
                [Cea#3@-13.813];

   %M#4.c2#1% !alcohol & cannabis (emerging adulthood)
                [Cea#1@8.665];
                [Cea#2@2.297];
                [Cea#3@-5.149];

   %M#4.c2#2% !normative (emerging adulthood)
                [Cea#1@1.354];
                [Cea#2@11.531];
                [Cea#3@-2.284];

   %M#4.c2#3% !high polysubstance (emerging adulthood)
                [Cea#1@-0.145];
                [Cea#2@0.358];
                [Cea#3@6.980];

  %M#4.c2#4% !low polysubstance (emerging adulthood)
                [Cea#1@-7.241];
                [Cea#2@-6.536];
                [Cea#3@-13.813];

Model M.C3:
   %M#1.c3#1% !cannabis (young adulthood)
                [cya#1@12.568];
                [cya#2@7.460];
                [cya#3@-1.242];

   %M#1.c3#2% !normative (young adulthood)
                [cya#1@7.375];
                [cya#2@13.814];
                [cya#3@0.0001];

   %M#1.c3#3% !high illicit (young adulthood)
                [cya#1@4.889];
```

```
                [cya#2@0.619];
                [cya#3@13.815];

%M#1.c3#4% !low polysubstance (young adulthood)
                [cya#1@-5.582];
                [cya#2@-5.249];
                [cya#3@-13.807];

%M#2.c3#1% !cannabis (young adulthood)
                [cya#1@12.568];
                [cya#2@7.460];
                [cya#3@-1.242];

%M#2.c3#2% !normative (young adulthood)
                [cya#1@7.375];
                [cya#2@13.814];
                [cya#3@0.0001];

%M#2.c3#3% !high illicit (young adulthood)
                [cya#1@4.889];
                [cya#2@0.619];
                [cya#3@13.815];

%M#2.c3#4% !low polysubstance (young adulthood)
                [cya#1@-5.582];
                [cya#2@-5.249];
                [cya#3@-13.807];

%M#3.c3#1% !cannabis (young adulthood)
                [cya#1@12.568];
                [cya#2@7.460];
                [cya#3@-1.242];

%M#3.c3#2% !normative (young adulthood)
                [cya#1@7.375];
                [cya#2@13.814];
                [cya#3@0.0001];

%M#3.c3#3% !high illicit (young adulthood)
                [cya#1@4.889];
                [cya#2@0.619];
                [cya#3@13.815];

%M#3.c3#4% !low polysubstance (young adulthood)
                [cya#1@-5.582];
```

```
                    [cya#2@-5.249];
                    [cya#3@-13.807];

     %M#4.c3#1% !cannabis (young adulthood)
                    [cya#1@12.568];
                    [cya#2@7.460];
                    [cya#3@-1.242];

    %M#4.c3#2% !normative (young adulthood)
                    [cya#1@7.375];
                    [cya#2@13.814];
                    [cya#3@0.0001];

     %M#4.c3#3% !high illicit (young adulthood)
                    [cya#1@4.889];
                    [cya#2@0.619];
                    [cya#3@13.815];

     %M#4.c3#4% !low polysubstance (young adulthood)
                    [cya#1@-5.582];
                    [cya#2@-5.249];
                    [cya#3@-13.807];

OUTPUT:   patterns TECH15  SVALUES;
SAVEDATA: file is 4444 MOVER STAYER CANNABIS adjusted model.dat;
          save = cprob;
          missflag = 999;
```

CURRICULUM VITAE

AMANDA M. HAGMAN

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Data Scientist: Decisions – Analysis – ROI
ABD Ph.D. in Sociobehavioral Epidemiology | Thesis Defense Planned September 2020

Identify research questions ripe for collaborative inquiry via data science, analysis, and visualization / reporting.
Design methodologies and interpret analytics to build real-world programs that elevate revenue and other key KPIs.
Model and explore customer / stakeholder behavior to maximize business leaders' innovation strategies.

DATA SCIENCE SKILLS AND EXPERTISE

Data Analysis | Data Wrangling | Data Visualization | Machine Learning | Modeling | Data Communication | Reporting
Experimental Design | Analytics | Statistics | Research | Methodology | R | PowerBI
Public Speaking | Change Management | Mentoring | Training | Technical Writing | Collaboration | Facilitating

PROFESSIONAL EXPERIENCE

Data Scientist | Data Wrangler / Adjunct Faculty / Graduate Researcher 2012–2020
Utah State University, Logan, UT

As data scientist keenly attuned to innovation, produced actionable and ROI-positive programs based on deep and broad expertise with data collection, cleaning, modeling, visualization, and interpretation via machine learning strategies. Built initiatives designed for real-world applications supporting needs of front-line program implementation. With exceptional emotional intelligence paired with superior knowledge, contributed 30% of time to working directly with individual and teams on training, message socialization, program follow-through, and measurement of results against program goals. Regularly presented at institutional and national levels on successful implementation of machine learning initiatives. Supervised 1 analyst and reported to Director of Center for Student Analytics.

SPONSORED ANALYTICS TOOL ADOPTION WITHIN UNIVERSITY CULTURE

Increased student retention 2.3%, representing $3M+ retained adjusted tuition. First-in-kind campus program beat prior retention average .25% annual increase and recouped 6-figure investment in first year post-implementation.

- With comprehensive data strategy and program implementation, proved departments with better analytics tool and program adoption rates improved student retention.
- Trained employees in one-on-one and formal sessions to understand tool value to them and to students, via shift in university interaction with them; focused on social integration of data tools, converting perception of program from challenge / hassle into must-have technology yielding clear, actionable information specifically addressing KPIs.
- Built additional tool tracking program adoption, focusing on employees unfamiliar with complexities of analytics and actively reaching out to struggling segments, while highlighting others' wins to show benefit of tool adoption.

SUPPORTED CULTURE SHIFT TO PROGRAMMATIC INTENTIONALITY AND INNOVATION

On-boarded 29 departments to evaluative analytics in program year 1, retaining 24 in years 2 and 3 (+32% and +15% tool adoption, respectively). One of these departments increased retained tuition 200% to $3M+ by year 3.

- Worked with variety of departments to shift to data-driven, focused KPI-targeting strategies as element of modernized organizational culture, leading university toward overall culture of programmatic intentionality and innovation; earned executive-level approbation and proved that innovation and impact followed participation.
- Overcame major technical and social challenges to adoption:
  - Using highly flexible suite of tools and analyses, created individualized department-level solutions that answered their KPI-specific research questions.
  - Instituted annual data sharing agreement, by which centrally housed data and project; tangible contract engaged data stewards and custodians to make data more easily accessible.
  - Enabled early-adopting departments to showcase their innovations and effects on student populations, encouraging broader institutional adoption.

SET STAGE FOR REVERSING IMPACTS ON HISTORICALLY MARGINALIZED POPULATIONS

Identified increased persistence of racially diverse students through participation in high-impact program by 5.0% (n=38, $180K+ tuition), anticipated to grow over time to 14% (n=112, $530K+ tuition) through serving students more equitably.

- In Inclusion Center's first quantification of real experience, publicized benefits on students from historically marginalized populations of reversing obstacles to retention via high-impact practice, although research revealed this population used

them less often than their peers (25% of diverse students, versus 45% of white students, participated each semester, because they did not believe in value).
- Actionable results produced by these data included: Requiring and allocating funds for sensitivity training for staff. Engaging Inclusion Center, Center for Student Affairs, and President of the University in conversation around insights from data along with experience from students.

DEVELOPED NEW MODEL FOR STUDENT RETENTION ACCOUNTING FOR COVID-19 IMPACTS

Identified opportunities to realize $2000 ROI per retained at-risk student with negligible outlay, testing and implementing several data models whose algorithms could shift as COVID-19 progressively affects university enrollments.

- Recognizing that university enrollment models, assumed to be relatively static, could change in face of COVID-19, examined social factors outside original model that might affect students' decisions to return to school.
- Created secondary model responsive to COVID-19 impact (87% overlap with prior model's historical data) that identified additional 350 students who would not have been prescribed outreach from original model.
  - Shifted department-level thinking on and best practices for proactive communication to students at risk.
  - Shared data insights with variety of University stakeholders to influence retention strategies; presented via podcast to National Association of Student Personnel Administrators (NASPA) community, sparking national conversations about models utilized at other universities.

DESIGNED MODEL TO IDENTIFY NEW OUT-OF-STATE MARKETS FOR STUDENT RECRUITMENT

Designed cost-efficient strategy to target geographies likely to house ideal prospective students.

- Evaluated historical data on out-of-state students from USU, census data, and secondary data source, and built data model to identify untapped advertising opportunities within markets similar to those providing current students, shifting strategy away from traditional targeting of geographies in proximity to current markets. Program is in A/B testing as of Q2 2020.

Evaluation Specialist **2015–2020**
Elevated Analytics & Evaluation, Salt Lake City, UT

Shifted perception of analytics from burdensome process to tool for data-driven program improvements for programs able to demonstrate connection between effective curriculum/resources and healthy adolescent decision-making. Developed and oversaw rigorous evaluation process for 3 clients, including design of client-specific logic models that connected resources and activity to outcomes and provision of data reporting for federal

institutions that regulate funding and accreditation. Closely monitored client progress and tracked fidelity to project while demonstrating benefits of adherence to evaluation requirements.

TRIPLED FEDERAL FUNDING FOR EDUCATION CLIENT

Created and produced data-driven evaluation strategies that informed progress toward achieving student well-being.

- Regularly reported to and conferred with executive leadership on logic models, further supporting culture shift with complex yet digestible data visualizations that informed clients' marketing strategies.
- Directly influenced reconstruction of curriculum that returned significant gain on measures of student well-being; for another client, evaluation results tripled next cycle's federal funding.
- Using advanced analytical techniques, identified comparison schools quickly and cost-efficiently, resulting in ideal 1:1 treatment-to-comparison ratio and zero comparison school dropouts in 2 academic years.
- Designed multifaceted incentive program that incentivized teacher, student, and parent participation. Program ran at capacity through school year and into next: 100% of the invited schools willing participated; 80% of classrooms reached their consent form goal and received incentive; and program reached participation goal for evaluation.

ADDITIONAL EXPERIENCE

- **Adjunct Faculty (Temporary),** *Utah State University, Logan, UT, 2018*. Taught research methodologies to first-year masters and doctoral students from non-quantitative disciplines as senior PhD student in quantitative field well-qualified above peers to teach incoming graduate students.
- **Project Manager, Prevention Science Laboratory,** *Utah State University, Logan, UT, 2014–2017*. Identified and enacted media strategies to attract Spanish speaking participants to research study. Trained 12 undergraduates to reach recruitment goal within budget and by 8.5 months (.5 months early) while cutting participant failure rate from 14% to 7%. Cleaned data and performed statistical analyses in R; created syntax for data analysis and visualization. Research adding to field of endocrine activation in stressful situations among youth was published and presented at academic conference. Selected for project leadership and scholarship from cohort of 24 graduate students.
- **Cellular Biologist, Caisson Laboratories,** *Logan, UT, 2006–2010*. Worked in epigenetic lab cultivating cells for research purposes. Researched intergenerational link between maternal diet and child susceptibility to cancer in mouse model.

VOLUNTEERISM

- Manos Unidos, 2008.
- English Language Learning Center aide, 2006–2008.

AWARDS FOR EXCELLENCE

- 2019 – Honorable Mention NASPA Assessment, Persistence, and Data Analytics: Data Wranglin'.
- 2018 – Nominated NASPA: Data Wranglin'.
- 2017 – Awarded 1st place in USU Graduate Student Research Symposium in Psychological Sciences.
- 2013 – Awarded Adele Young Scholarship.
- 2013 – 3rd place Executive Summary Competition Huntsman Business School.

PROFESSIONAL DEVELOPMENT

- **Ph.D.,** Sociobehavioral Epidemiology, emphasis in prevention science, Utah State University, Logan, UT. Dissertation: "Maturing-out of risky substance user in young adulthood: Impacts on young adult psycho-social outcomes." Dissertation defense anticipated September 2020.
- **Master of Science,** Human Development, emphasis in program evaluation, Utah State University, Logan, UT. Thesis: "Father–Child Play & Child Emotional Regulation."
- **Bachelor of Science,** Biology, emphasis in genetics, Utah State University, Logan, UT.