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Moving Forward: Studying the Impact of Future Self-Continuity and Active Commuting on Depression, Anxiety, and Stress

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Moving Forward: Studying the Impact of Future Self-Continuity and Active Commuting on Depression, Anxiety, and Stress

Senior Project Submitted to

The Division of Science, Math, and Computing

of Bard College

by

Max Gehr

Annandale-on-Hudson, New York

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Dedication

To the dear friends that I have made at Bard College. Your empathy, humility, steadfastness, and unwavering support have served as the bedrock on which my academic and spiritual journey has developed. The time I have spent by your side has sculpted me form after form, ushering me toward the man I have become—a man that I can be proud of. Together, we have laughed until tears and cried until laughter, and with you I have grown in ways I could never have imagined. I am deeply grateful to have been welcomed to share my days and nights with those that I so strongly admire. Thank you for being an integral part of my story.

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Abstract

The current research delves into the relationship between Future Self-Continuity (FSC) and mental health, particularly in the context of commuting behaviors. It employs a cross-sectional, observational design and relies on self-reported data. While this approach provides helpful perspicuity into the nature of the observed phenomena, it also expresses methodological limitations in terms of causal inference and variable control and manipulation. The study utilizes established psychometric tools as a basis for modified measures for the sake of brevity and digestibility by recruited online participants: the Truncated Future Self-Continuity Questionnaire (FSCQ-T) and the Depression Anxiety and Stress Scale-10 (DASS-10), to measure the respective constructs.

A linear regression analysis reveals a significant negative correlation between FSCQ-T and DASS-10 scores ($n = 90$, $r = -0.321$, $p = 0.002$). This finding suggests that individuals with a stronger sense of connection to their future selves tend to experience better mental health outcomes. However, the two-group t-tests reveal no significant differences between active and inactive commuters in FSCQ-T ($n = 90$, $t = -0.189$, $p = 0.851$) and DASS-10 ($n = 90$, $t = 0.205$, $p = 0.838$) scores. This outcome indicates that commute type may not significantly influence these specific aspects of mental health.

However, the research is limited by its cross-sectional design, reliance on self-reported data, and inability to control and manipulate its variables, which constrain causal inferences and long-term observations, and allow for confounding variables to obfuscate and skew potential effects. Acknowledging these limitations, the study underscores the need for future longitudinal research with diverse samples to deepen our understanding of the interplay between commuting patterns, mental health, and FSC, offering valuable insights for urban planning and public health.

Introduction

Background

The dawn of the Industrial Revolution transformed the working structure of Western society, leading to the emergence of large-scale industrial and corporate jobs. Consequently, work and life became more distinct, with many working farther from their homes due to industrial zoning regulations that mandated separation between workplaces and residential areas (Stromberg, 2016). To facilitate the movement of the workforce, expansive infrastructures were developed, specifically catering to the transportation needs of workers commuting to and from their jobs.

Prior to the Industrial Revolution, modes of transport were largely limited to walking, horseback riding, and carriages drawn by horses. In predominantly rural societies, the concept of long-distance travel was often irrelevant; most people's livelihoods were tied to their immediate surroundings. Travel was generally restricted to short distances for the bulk of the population, with the exception of the affluent, who could afford private modes such as horse-drawn carriages for their journeys. It was unusual for most U.S. residents to commute more than a few miles for work or other necessities. The advent of rail transportation marked a pivotal shift, introducing the general public to the conveniences of mass transit. As cities expanded, the allure of urban rail systems grew, leading to an uptick in the use of inner-city trams and trains. This was further enhanced as intercity rail travel evolved, becoming more economical and comfortable, and it quickly became the transport of choice in the post-industrial era (Stromberg, 2016). This changed with the development of suburban neighborhoods in the 1950s. For those with lengthier commutes, public transportation systems gained popularity in the latter half of the 19th century, including passenger trains and river ferries. Additionally, cities constructed electric streetcar

lines that could accommodate large numbers of commuters. Streetcars were particularly advantageous in cities with steep terrain, offering a more accessible mode of transport for individuals with disabilities. Consequently, streetcars became widely popular in urban centers across the United States (Stromberg, 2016).

As the automobile became more accessible with time, the popularity of personal vehicles surged, ultimately transforming the landscape of work commutes in the United States and other Western countries. Henry Ford's Model T, introduced in 1908, revolutionized the automotive industry by making cars affordable for the average working-class family. This newfound accessibility of automobiles led to a significant shift in commuting patterns as people began to rely more on personal vehicles for transportation to and from work. The expanding road networks and the establishment of highways facilitated this shift toward automobiles, further enabling people to travel longer distances for their daily commutes. This allowed for the growth of suburban neighborhoods, as individuals and families sought the comfort of more spacious homes and the perceived safety of suburban living while still maintaining access to job opportunities in urban centers. The widespread adoption of the automobile also had unintended consequences for public transportation systems. Many streetcar lines and passenger railways experienced a decline in ridership, as people increasingly chose the convenience and privacy of their own cars over shared transportation options. As a result, investment in public transportation waned, leading to a cycle of deteriorating infrastructure and service quality, which further drove people toward personal vehicles (Stromberg, 2016).

Commuting and Health Outcomes

The extensive use of automobiles, as Ding et. al. (2014) highlights, has been associated with various adverse health outcomes. The cross-sectional study examined the relationship between driving times and multiple health behaviors and outcomes. Utilizing data from the Social Economic and Environmental Factor Study in New South Wales, Australia, the research encompassed a large sample size of 37,570 middle-aged and older adults. Adjusting for socio-demographic characteristics, Ding et. al. explores the associations between driving time and health-related behaviors, such as smoking, alcohol use, diet, and physical activity, and outcomes such as obesity, psychological stress, general health, and social functioning. Longer driving times correlate with higher odds of smoking, obesity, and poorer physical and mental health due to factors like traffic congestion and reduced time for physical activity (Ding et al., 2014).

Gatersleben and Uzzell (2007) add that car commuting is often more stressful than other modes of transport, with delays and interactions with other road users as primary stressors. Using a survey methodology, the study gathered data from university employees, emphasizing their affective responses (stress, excitement, pleasure, etc.) to various commuting modes. It diverges from traditional research that has predominantly concentrated on utilitarian and cognitive evaluations of travel, highlighting the emotional aspects of commuting, such as stress and boredom. The study found that car commuters generally experience more stress due to delays and interactions with other road users. In contrast, walking and cycling are perceived as more relaxing and exciting, suggesting these as optimal travel forms from an affective standpoint (Gatersleben & Uzzell, 2007).

As Gatersleben and Uzzell (2007) suggest, transitioning to more active forms of transportation like walking and cycling can improve psychological well-being. Martin (2014) found significant associations between overall psychological well-being and active travel, with switching from car travel to active modes particularly beneficial. Utilizing data from a large sample of 17,985 adult commuters from the British Household Panel Survey spanning from 1992 to 2009, Martin et. al. (2014) employs fixed effects regression models to allow for an examination of the impact of travel mode choice, commuting time, and switching to active travel on overall psychological well-being and psychological symptoms in the General Health Questionnaire. The results demonstrate significant associations in several of the proposed effects. Martin et. al. support a significant relationship between psychological well-being and active travel modes, including walking and public transport, when compared to car travel. More specifically, switching from car travel to active travel was associated with improvements in well-being. Furthermore, the study finds that time spent walking also positively correlates with enhanced perceived well-being, while time spent driving has the opposite effect. Notably, the likelihood of experiencing stress-related symptoms, such as an inability to concentrate or feelings of being under constant strain, was significantly higher among car commuters than those engaging in active travel. This study, employing a longitudinal model, provides unique and significant findings in the field of commute behavior and health research (Martin et al., 2014).

Avila-Palencia et al. (2018) corroborate these findings, noting that bicycle use is associated with good self-perceived health, lower stress, better mental health, and fewer feelings of loneliness. As part of the Physical Activity through Sustainable Transport Approaches (PASTA) study—a longitudinal study conducted over two years in several European cities, the study examines mental health and social contact measures between various modes of

transportation. The methodology included mixed-effects logistic regression, linear regression, and logistic regression models to analyze the associations, adjusting for potential confounders. Both single and multiple transport mode models were assessed to determine their impact on self-perceived health, mental health, and social contact measures. The results indicate that bicycle use is linked with improved self-perceived health, reduced perceived stress, enhanced mental health, increased vitality, and fewer feelings of loneliness. Walking is also positively correlated with better self-perceived health, higher vitality, and more frequent social contact with friends and family. On the other hand, more frequent use of cars and public transport is associated with poorer self-perceived health and lower vitality, although car use was also linked to fewer feelings of loneliness. The results for motorbike and e-bike use were inconclusive (Avila-Palencia et al., 2018).

However, the transition from car to bicycle is not without its risks. De Hartog et al. (2010) focus purely on the transition from car to bicycle commuting. They note that while the modal shift from car to bicycle has societal benefits like decreased air pollution and increased physical activity, it also increases individuals' exposure to air pollution and the risk of traffic accidents. Using a combination of systematic reviews and recent key studies, the research synthesizes data on air pollution, traffic accidents, and physical activity to quantify the impact on all-cause mortality. The study estimates the effects on mortality when 500,000 individuals transition from car to bicycle for short trips daily in the Netherlands. The findings are expressed in terms of life-years gained or lost, using life table calculations. The study concludes that for individuals who shift from car to bicycle, the health benefits from increased physical activity are significantly larger than the risks associated with increased air pollution exposure and traffic accidents. Specifically, the beneficial effects of physical activity were found to outweigh the

potential mortality effects of increased air pollution doses and traffic accidents, resulting in an overall gain in life expectancy. The analysis indicated that the health benefits of cycling were approximately nine times greater than the risks when compared to car driving for individuals making the mode shift (De Hartog et al., 2010).

This body of research shows the significant role that commuting plays in the daily lives of individuals. Commute mode has a significant impact on various aspects of mental and physical health. Consequently, research into this field is imperative for furthering the general well-being of the general population and promoting the development of infrastructure that supports the variety and availability of multimodal travel. In order to encourage the use of healthier commute practices, it is imperative to understand the mechanisms that guide motivational behaviors in our society.

The Concept of Future Self-Continuity (FSC)

The concept of future self-continuity delves into the intriguing intersection of human perception, temporal understanding, and self-identity. At its core, future self-continuity, a subcategory of the more general study of self-continuity, refers to the degree to which individuals perceive their future selves as a continuation of their current selves. An example of future self-continuity could be an individual's approach to retirement savings. A person with a high degree of future self-continuity is likely to identify closely with their future retired self, and as a result, they may be more inclined to save money and make financial plans for old age. They see their future comfort and security as a direct continuation of their present efforts and therefore prioritize actions that will benefit them in the long term. This reflects a strong psychological link between their current identity and who they will become in the future.

Historically, the roots of this concept can be traced back to philosophical discussions about the nature of identity and the passage of time. Philosophers such as John Locke grappled with questions concerning personal identity and what it means for a person to remain the same over time (Locke & Nidditch, 1979). John Locke's essay "An Essay Concerning Human Understanding" discusses the nature of identity and personal identity over time. His theory of personal identity over time is centered around consciousness. In his view, personal identity is founded on the continuity of consciousness.

According to Locke, it is consciousness that connects one's past to one's present and future self. He posits that one's identity extends as far back in time as their memory reaches. Therefore, personal identity is not tied to the soul or the body, both of which can undergo changes independent of consciousness (Locke & Nidditch, 1979). Locke's account suggests that it is the same consciousness that makes a person the same over time, even if they change fundamentally in other aspects. This concept, found in the chapter "Of Identity and Diversity" in his essay, was groundbreaking and remains influential in philosophy and psychology. Locke's argument is central to understanding how individuals perceive their current selves as connected to their future selves. His work emphasizes the role of memory and consciousness in maintaining personal identity across different time points, and his philosophical inquiries lay the groundwork for the psychological construct of future self-continuity.

The systematic research into future self-continuity, however, began more recently, mainly in the late 20th and early 21st centuries, within the realms of psychology and neuroscience. This recent surge of interest was driven by the realization that people's connection with their future selves might significantly impact their decision-making processes, especially concerning

long-term planning and delayed gratification (Ersner-Hershfield et al., 2009; Hershfield et al., 2012).

A major revelation from these studies was the finding that some people view their future selves almost as distinct individuals, leading them to devalue future rewards in favor of immediate ones. This has profound implications in areas like financial planning and health behaviors (Bryan & Hershfield, 2012; Milkman et al., 2011). Over the years, future self-continuity has become a key concept in understanding why individuals might procrastinate, avoid saving for retirement, or make choices detrimental to their long-term well-being (Hershfield et al., 2012; Soman & Zhao, 2011).

James' Theory of the Self

During the birth of psychology as a science at the turn of the 20th century, philosopher William James laid the foundation for the study of self-continuity in his seminal book *Theory of the Self* (James, 1890). James's Theory of the Self describes not only a subjective "I" that exists within one's perception, but also an accompanying objective "Me" that exists as external to one's lived experience. The dichotomy between the subjective "I" and the objective "Me" has remained central in discussions of the self. The "I" represents the self that is the knower, the experiencer – the immediate consciousness present in our daily experiences. On the other hand, the "Me" can be understood as the known self – the accumulated knowledge and evaluations of oneself based on past actions, societal feedback, and constructed identities (James, 1890). While we continually experience the world through the I, our sense of global continuity through our past experiences and our interpretations of the future is understood through our perception of the

"Me," which aggregates our factual, episodic experiences into a cohesive narrative (Hadar et al., 2022).

This abstract construction of the conceptual self through the aggregation of episodic facts is seen even in patients who experience detrimental effects to their episodic memory. The work of Conway and Pleydell-Pearce (2000) delves into this phenomenon, outlining a model where memory is not a static entity but a dynamic process within the self-memory system (SMS). This system integrates autobiographical knowledge and the goals of the working self, employing generative retrieval processes that are capable of constructing memories even when access to specific episodic details is impaired. The methodology they describe illustrates how a continuous, coherent self can be maintained through these generative processes, supporting the resilience of self-identity despite the loss of certain memories. This finding demonstrates that our identity is not merely a collection of specific memories, but rather a complex synthesis of those memories into a broader self-concept. Even when particular episodic memories fade or become inaccessible due to neurological disorders or aging, the essence of who we are, our values, beliefs, and overarching life narrative, often remains intact (Conway & Pleydell-Pearce, 2000).

This resilience of the self-concept—despite compromised memory systems—underscores the adaptive nature of our psyche. It suggests that our brain has evolved mechanisms to prioritize the preservation of a cohesive self-identity, which may serve critical functions in maintaining self-esteem, facilitating social interactions, and guiding future-oriented behaviors (Prebble et al., 2013). The study by Prebble et al. (2013) proposes a new framework to understand the relationship between autobiographical memory and the sense of self. This framework addresses a gap in psychological research. The framework is based on two dimensions of self: subjective (our conscious experience) and objective (our mental representation across time). A key finding

in the study is that the subjective sense of self is essential for episodic memory, which in turn is critical for our sense of continuity over time. Autobiographical memory, in its more abstract forms, is fundamental in forming and maintaining our objective self-concept both in the present and over time. Additionally, the study highlights the importance of prereflective self-experience, characterized by an inherent sense of personal ownership and agency, which is integral to our conscious experience. Self-awareness is identified as a critical precursor to episodic memory, enabling introspection and the differentiation of personal experiences. The framework also provides insights into conditions like schizophrenia, where disruptions in self-experience can lead to difficulties in relating personal memories to the self. Prebble et al.'s work offers a comprehensive model connecting aspects of self with autobiographical memory. In essence, while specific memories contribute to the richness of our life story, it is the broader narrative, the "Me," that truly defines and shapes our sense of self-continuity across time.

Self-Preservation and Self-Enhancement

Given the intricate relationship between present-future self-continuity and the cognitive mechanisms that govern our behaviors, it's paramount to explore how continuity of the self-identity serves as a motivational force to better understand and develop methods to enhance motivations, performance, goal achievement, and wellbeing. Specifically, this force can be understood through two cognitive phenomena: self-preservation and self-enhancement.

At its core, self-preservation revolves around an individual's inherent drive to maintain a consistent and coherent self-concept over time, ensuring psychological stability and reducing cognitive dissonance (Festinger, 1957). Cognitive dissonance is a foundational phenomenon in the study of social psychology that refers to the tension and discomfort experienced when one

holds two or more contradictory beliefs. Festinger affirmed the theory of cognitive dissonance in his seminal work. In one of his foundational studies, participants were given either a large or small reward to mislead the subsequent participant by stating that the task was enjoyable. As predicted, those who received a smaller reward tended to rate the task as more enjoyable, suggesting an internal effort to reconcile the disparity between their actions and inherent beliefs or values. This research laid the groundwork for the theory of self-preservation in the self-concept, exhibiting that when faced with potential threats to one's self-concept, individuals tend to engage in behaviors that reaffirm their sense of identity and continuity (Festinger, 1957).

Conversely, self-enhancement refers to the tendency of some individuals to perceive and present themselves in a favorable light, often emphasizing their positive attributes while downplaying the negatives. This can motivate individuals to set future-oriented goals that reflect this favorable self-view, aiming for better life outcomes in various domains, from health to finance to personal growth (Taylor & Brown, 1988). The 1988 study by Taylor and Brown challenges traditional views of mental health by suggesting that positive illusions—overly optimistic self-evaluations, exaggerated perceptions of control, and unrealistic optimism—are common and beneficial for mental health. Their conclusions were drawn from a comprehensive review of existing social, personality, clinical, and developmental psychology research, focusing on the correlations between these illusions and aspects of mental well-being, such as happiness, social bonding, and work performance. The study found that these illusions can enhance happiness, improve social relationships, and increase motivation and effectiveness in work, particularly in the face of adversity or negative feedback. This suggests a more nuanced understanding of mental health, where a balance between realistic assessments and positive illusions may be key to overall well-being.

The notion of self-enhancement is not without debate. Scholars are divided over whether self-enhancement operates primarily as an adaptive mechanism, fostering resilience and motivation, or as a maladaptive trait, potentially leading to overconfidence and interpersonal conflicts.

Proponents of self-enhancement's adaptive nature argue that a positive self-view can act as a buffer against adversities, reducing stress and improving overall well-being (Taylor & Armor, 1996; Taylor & Brown, 1988). The article by Shelley E. Taylor and David A. Armor, titled "Positive Illusions and Coping with Adversity," explores the concept of positive illusions—self-aggrandizement, unrealistic optimism, and exaggerated perceptions of control—and their role in adjusting to stressful and traumatic events. The authors review extensive literature and empirical evidence to integrate these illusions with the constraints of reality. They contrast the social psychological model of positive illusions with personality viewpoints, examining various stressful scenarios, including severe health conditions like cancer and HIV. The paper posits that while these illusions can be a form of mild distortion of facts, they generally remain within realistic bounds due to social feedback and play a crucial role in psychological adjustment and coping. The authors also delve into the potential maladaptiveness of these illusions when they conflict with reality, suggesting that they can still be adaptive in deteriorating situations due to the flexibility of coping strategies. Additionally, the paper discusses the cultural context of these phenomena and their universality, highlighting that the specific forms of positive illusions might vary across cultures. The article thus provides a comprehensive view of positive illusions as a dynamic element in coping mechanisms and psychological well-being.

On the other hand, critics of self-enhancement highlight the potential dangers of overestimating one's capabilities or misjudging social cues. Overconfidence, a byproduct of self-enhancement, can lead to risky decisions, as individuals may not accurately assess challenges or potential pitfalls (Kruger & Dunning, 1999). In their 1999 study, "Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments," Kruger and Dunning explored what is now known as the Dunning-Kruger effect. They conducted experiments where participants rated their ability in humor, logic, and grammar tasks. The findings revealed that participants with lower performance significantly overestimated their abilities, while high performers tended to underestimate theirs, demonstrating a misalignment between perceived and actual skills. This research highlighted a fundamental miscalibration in self-perception, particularly among those with lesser skills, and has important implications for understanding cognitive biases and self-assessment accuracy. Moreover, continuous self-enhancement can strain interpersonal relationships, as others may perceive the individual as arrogant or out of touch with reality (John & Robins, 1994). In their 1994 study, "Accuracy and Bias in Self-Perception: Individual Differences in Self-Enhancement and the Role of Narcissism," John and Robins investigated the accuracy of self-perceptions and the influence of narcissistic traits on this self-assessment. They compared individuals' self-ratings on various traits with assessments made by acquaintances to measure self-perception accuracy. The findings indicated a general trend towards self-enhancement, where most people overestimated their positive qualities. This tendency was particularly pronounced in individuals with narcissistic characteristics. The study highlighted the substantial role of individual differences—especially personality traits like narcissism—in shaping self-perception, revealing the intricate nature of

how personality influences the way individuals perceive and present themselves (John & Robins, 1994).

Motivation and Behavior

Self-continuity as a motivational and behavioral force is a compelling specialization of study that bridges the gap between self-perception and behavior. The degree to which individuals perceive their future selves as a continuation of their present selves significantly influences their motivation and decision-making. In essence, a strong sense of future self-continuity can act as a powerful motivator for individuals to engage in behaviors that are beneficial in the long term, even if they require sacrifice or effort in the short term.

Research by Ersner-Hershfield et al. (2009) and Bartels & Rips (2010) delves into how individuals' connectedness with their future selves influences future-oriented behaviors, such as saving and health maintenance. These studies highlight that a stronger sense of future self-continuity mitigates the effects of temporal discounting, where immediate rewards are often valued more highly than future ones. The 2009 study, comprising three experiments, investigated how individuals' perceptions of their future selves influenced their financial decisions. The first experiment introduced a measure for future self-continuity and linked it to decision-making in a monetary reward task, finding that a stronger sense of connection to the future self correlated with less discounting of future rewards and increased saving behavior. The second study reinforced these findings by further validating the FSC measure and confirming its positive association with valuing future rewards. Finally, the third experiment demonstrated a real-world application by showing that higher future self-continuity was associated with greater accumulated assets in an adult population. This research highlighted the significant impact of

how individuals perceive their future selves on their savings and financial planning, suggesting that enhancing future self-continuity could promote better financial behavior (Ersner-Hershfield et al., 2009).

The study by Bartels and Rips (2010), titled "Psychological Connectedness and Intertemporal Choice," aimed to explore how individuals' perceptions of their present and future selves affect their preferences for immediate versus delayed rewards. The methodology involved several experiments where participants were asked to make decisions about receiving monetary and nonmonetary rewards at different future times. They were also asked to rate their sense of connectedness with their future selves at these various times. The central finding was that participants demonstrated a greater preference for receiving benefits sooner when they felt less psychologically connected to their future selves. This trend was consistent across different experimental setups and reward types. The study concluded that the degree of psychological connectedness one feels with their future self significantly influences their preference for immediate versus delayed gratification. This research contributes to the understanding of how perceptions of self-identity over time can impact financial and other intertemporal choices (Bartels & Rips, 2010).

Hershfield (2011) further emphasizes this point, suggesting that a similar, positive, and vivid image of the future self enhances the perceived value of long-term rewards, aligning them more closely with immediate ones. Hershfield's review of the existing literature leads him to posit that a disconnected, othered view of oneself in the future can limit the mitigating effects of self-continuity on temporal discounting. He emphasizes that when people see their future selves as similar to their present selves, rather than separate or distinct, they are more likely to make decisions that favor long-term benefits, such as saving money or making healthy lifestyle

choices. Moreover, the study highlights the importance of the vividness with which individuals can imagine their future selves. Hershfield suggests that a more vivid and detailed conception of one's future self can strengthen the psychological connection between the present and the future, leading to more future-oriented decision-making. This aspect of the study underscores the potential of using vivid and detailed imagery of the future self as a tool to enhance future self-continuity, thereby positively influencing behaviors that have long-term implications (Hershfield, 2011).

Spreng & Grady (2010) contribute by demonstrating the neurological basis for this phenomenon, showing how brain activity patterns associated with thinking about the future self are linked to better planning and foresight. They hypothesized that these processes are mediated by the Default Mode Network (DMN). Using functional magnetic resonance imaging (fMRI) and a multivariate method known as partial least squares (PLS), the study examined brain activity during these tasks to see if it corresponded with the DMN. Additionally, they conducted a functional connectivity analysis to explore this relationship further.

The study found that autobiographical memory, prospection, and theory-of-mind shared a common pattern of neural activity, indicating a significant overlap in the brain regions activated during these tasks. This pattern included the activation of midline structures in the frontal and parietal lobes, as well as left-lateralized activation in several regions. However, the study also revealed differences: autobiographical memory and prospection showed greater activity in frontal and parietal midline structures and the hippocampal formation, while theory-of-mind primarily engaged lateral temporal regions and the right temporo-parietal junction. Functional connectivity analysis confirmed the involvement of the DMN in these processes, particularly the medial prefrontal cortex (MPFC), a key node of the DMN, which showed a significant

correlation with activity in other core regions of the DMN during these tasks. This study underscores the role of the DMN in supporting cognitive processes related to personal and social cognition (Spreng & Grady, 2010).

The Relationship between Physical Activity and Mental Health

The relationship between physical activity and mental health is a field of profound significance in both medical and psychological research and has garnered an astronomical surplus of scientific attention. As modern society grapples with an increasing prevalence of mental health disorders, alternative and complementary therapies to traditional pharmacological treatments have become widespread and essential. Among these, the role of physical activity, particularly in the form of aerobic exercise, has emerged as a potent tool not only for physical wellbeing but also for mental health.

The earliest investigations into the relationship between physical activity and mental health outcomes in psychology can be traced back to the late 19th and early 20th centuries. Notable figures in this early exploration include G. Stanley Hall, the founding president of the American Psychological Association, and William James. In 1908, in the *Proceedings of the National Education Association*, Hall emphasized that "psychical education is for the sake of mental and moral culture and is not an end in itself. It is to make the intellect, feelings and will more vigorous, sane, supple and resourceful," suggesting a holistic approach to physical and mental vigor (National Education Association of the United States, 1908, p. 1015-1016). William James, a pioneer of the aforementioned concept of the Theory of the Self, also wrote about the importance of the "well-trained and vigorous body" for a "well-trained and vigorous mind" in his book *Talks To Teachers On Psychology; And To Students On Some Of Life's Ideals* (James,

1958). Hall's and James's remarks foreshadow contemporary topics in exercise psychology, including the impact of physical activity on mental well-being and its effect on cognitive abilities.

In modern contexts, aerobic exercise's role in mental health, particularly regarding depression, anxiety, and stress, has been the subject of extensive research. A substantial body of evidence indicates that physical activity, encompassing both aerobic and resistance exercise, shows promise in therapeutic applications for mental health conditions, especially depression.

Effects on Depression & Anxiety

Epidemiological studies have consistently shown that higher levels of physical activity are associated with reduced odds of developing depression and anxiety. Randomized trials have generally supported these findings, demonstrating that exercise, particularly aerobic training, can improve depression- and anxiety-related outcomes, with effect sizes comparable to conventional pharmacotherapeutic approaches. However, long-term benefits hinge on sustained exercise engagement.

A study by Blumenthal et al. (1999) provides a comprehensive examination of the effectiveness of aerobic exercise compared to standard medication for treating Major Depressive Disorder (MDD) in older adults. The study employed a randomized controlled trial design, including various assessments like the Hamilton Rating Scale for Depression and measures of life satisfaction and self-esteem. Their findings showed significant reductions in depression scores across all groups, including exercise, medication, and combined therapy, demonstrating that exercise can be as effective as antidepressants in treating depression in older adults (Blumenthal et al., 1999). Blumenthal's result is generally supported by current literature, and

has recently been partially replicated (Hidalgo et al., 2021). The article by Jesús López-Torres Hidalgo and Joseba Rabanales Sotos evaluates the effectiveness of physical exercise compared to antidepressant drugs in reducing depressive symptoms in older adults. A randomized clinical trial involving 347 patients aged 65 years and above with clinically significant depressive episodes was conducted. Participants were assigned either to a supervised physical exercise program or to receive antidepressant treatment. The study found that after one month, the improvement in depressive symptomatology was not significantly different between the physical activity and antidepressant treatment groups. However, at 3 and 6 months, the antidepressant treatment group showed a significantly greater improvement. The number of withdrawals was higher in the physical activity group, while the proportion of participants with adverse side effects was higher in the antidepressant treatment group. Although initial improvement was similar in both treatment groups, antidepressant treatment was superior in the medium term, despite a higher number of adverse effects. These findings challenge Blumenthal's hypotheses, advocating for the use of physical activity as a complementary enhancement to standard antidepressant treatment, rather than a standalone alternative. Additionally, they bolster the viability of physical activity as an alternative treatment option for older individuals seeking to avoid pharmacological interventions.

The relationship between physical activity and anxiety, including generalized anxiety and panic disorder, has proven to be more complex. A study by Lattari et al. (2017), “Effects of Aerobic Exercise on Anxiety Symptoms and Cortical Activity in Patients with Panic Disorder: A Pilot Study,” offers valuable insights. This study explored the acute and chronic effects of aerobic exercise on anxiety symptoms in patients with Panic Disorder (PD). Utilizing methods such as aerobic exercise protocols on a treadmill and psychological evaluations including the

Beck Anxiety Inventory and the Beck Depression Inventory-II, the study found that regular aerobic exercise led to a reduction in anxiety levels, highlighting the therapeutic potential of physical activity in managing anxiety disorders (Lattari et al., 2018). However, the nature of this pilot study indicates that a significant statistical power cannot be reached to draw any conclusions. An earlier study by Broocks et. al. (1998) aimed to compare the therapeutic effects of regular aerobic exercise with clomipramine (an anxiolytic treatment) and placebo in treating patients with moderate to severe panic disorder, with or without agoraphobia. This 10-week treatment study involved 46 outpatients, who were randomly assigned to either a regular aerobic exercise regimen (running), clomipramine treatment (112.5 mg/day), or placebo pills. Both exercise and clomipramine treatment led to a significant decrease in panic disorder symptoms compared to placebo. This was determined through various efficacy measures such as the last-observation-carried-forward method and completer analysis (Broocks et al., 1998).

The relationships presented between anxiety and physical exercise have proven to be inconclusive and often contradictory. A recent and substantial review by McDowell et. al. (2019) sought to examine the relationship between physical activity and anxiety. The studies included peer-reviewed prospective cohort studies with physical activity measured at baseline and anxiety assessed at a defined follow-up, at least one year later. McDowell et. al. conducted a meta-analysis for three outcomes: self-reported anxiety symptoms, any anxiety disorder diagnosis, and generalized anxiety disorder diagnosis. The quality of studies was assessed using the Q-Coh tool, categorizing studies as low, acceptable, or good quality based on various domains including representativeness, comparability, exposure and outcome measures, attrition, and statistical analyses. 24 studies were considered, with over 80,000 individuals, with a median follow-up of 4.75 years. Thirteen of these were included in the meta-analyses. The models

showed that odds of elevated anxiety symptoms, any anxiety disorder, and specifically generalized anxiety disorder were significantly lower after physical activity exposure (McDowell et al., 2019). These findings highlight the potential of exercise as a therapeutic tool in managing anxiety disorders, though further research is needed to fully understand the mechanisms and optimize exercise recommendations.

Biological Mechanisms

In exploring the biological mechanisms behind the impact of exercise on mental health, several studies highlight the crucial role of neuroplasticity in reducing symptoms of mood disorders, which is significantly influenced by physical activity. Exercise promotes neurobiological remodeling in key brain circuits, essential for adaptive learning and mental health, involving neurogenesis, synaptic plasticity, and neurotransmitter function. The hippocampus and prefrontal cortex are particularly responsive to these exercise-induced changes. Growth factors like brain-derived neurotrophic factor (BDNF), vascular endothelial growth factor (VEGF), and insulin-like growth factor-1 (IGF-1), enhanced by exercise, play crucial roles in these processes (Bathina & Das, 2015; Pittenger & Duman, 2008; Zoladz et al., 2008).

BDNF (Drain-Derived Neurotrophic Factor) and VEGF (Vascular Endothelial Growth Factor) play crucial roles in brain health and are aprticularly relevant to the mechanisms that underlie depression and anxiety. The study of these factors has taken precedence in recent research involving the study of behavioral mechanisms that can cause and prevent mood disorders. BDNF is essential for neuroplasticity, supporting neuron survival and synaptic connections, with lower levels observed in depression and anxiety disorders; its increase through treatments like exercise and antidepressants is linked to improved outcomes. VEGF, also known

for promoting blood vessel formation, also contributes to brain health by ensuring adequate blood supply, and has been implicated in neurogenesis. Reduced levels of VEGF and BDNF are associated with depression, anxiety disorders, and neurodegenerative diseases including Alzheimer's (Bathina & Das, 2015; Pittenger & Duman, 2008; Zoladz et al., 2008).

A study by Zoladz et al. (2008) focused on the effects of moderate intensity endurance training on plasma Brain-Derived Neurotrophic Factor (BDNF) levels in young, healthy men. Over a five-week period, thirteen participants engaged in endurance cycling, with the aim of determining how such training would influence both basal and exercise-induced BDNF concentrations. Methodologically, the study measured BDNF levels before and after the training program. Initially, resting BDNF levels among participants were 10.3 ± 1.4 pg/ml, which did not significantly change after participants engaged in a single exercise session. Post-training, there was a notable increase in resting BDNF levels to 16.8 ± 2.1 pg/ml and a significant rise to 68.4 ± 16.0 pg/ml after participants completed an exercise. This finding is crucial as it demonstrates that moderate-intensity endurance training can significantly elevate BDNF levels, a key factor in brain health and function, contrasting with previous findings linking high BDNF levels with metabolic risk factors in older age groups (Zoladz et al., 2008).

Another study, by Pittenger and Duman (2008), supports the link between neuroplasticity and decreased depression symptomatology by evaluating the effects of antidepressant treatments on the expression of neurotrophic factors such as BDNF and Vascular Endothelial Growth Factor (VEGF). They delve into how these treatments not only enhance neuroplasticity through upregulating critical signaling pathways like the cAMP-PKA-CREB and MAPK cascades but also regulate key molecules like CaMKII. This analysis reveals the multifaceted role of antidepressants in modulating the neurobiological mechanisms disrupted in mood disorders,

contributing to a reduction in depressive symptoms through the restoration and enhancement of neuroplastic processes. The evidence that neuroplasticity plays a crucial role in treating mood disorders with antidepressant medication strengthens the argument for using exercise, especially aerobic exercise, as an alternative or augment to traditional treatment. This is because exercise exhibits the same neuroplastic effects on the brain as antidepressant medication (Bathina & Das, 2015; Pittenger & Duman, 2008).

In conclusion, the interplay between physical activity and mental health, particularly in relation to depression and anxiety, presents a compelling area of study with far-reaching implications for both clinical practice and public health policy. The research, spanning from early psychological theories to modern empirical studies, consistently highlights the positive impact of physical activity, especially aerobic exercise, on mental health. Studies like those of Lattari et al. (2017) and Blumenthal et al. (1999) have been pivotal in demonstrating the tangible benefits of exercise in reducing symptoms of mental health disorders, comparable to traditional pharmacotherapies (Blumenthal et al., 1999; Lattari et al., 2018). These benefits are not only psychological but also deeply rooted in biological mechanisms, as evidenced by studies focusing on neuroplasticity and neurotrophic factors like BDNF and VEGF (Pittenger & Duman, 2008; Zoladz et al., 2008). The work of Zoladz et al. (2008) and Pittenger and Duman (2008) illustrates the profound impact of exercise on enhancing neuroplasticity, a crucial factor in combating depression and anxiety. The evidence overwhelmingly suggests that incorporating physical activity into mental health treatment strategies can lead to improved outcomes, offering a holistic approach to tackling these increasingly prevalent disorders. As such, promoting physical activity could be a key strategy in enhancing mental health, emphasizing the necessity for integrated approaches in mental health care that address both the mind and the body.

The Interplay between FSC, Commuting, and Mental Health

In summation, the impact of commute mode on mental health is multifaceted. Ding et al. (2014) identified a direct correlation between extended driving times and adverse health behaviors and outcomes, including psychological stress. Similarly, Gatersleben and Uzzell (2007) found that car commuting often induces more stress compared to active modes like walking and cycling, which are perceived as more relaxing and exciting. Martin (2014) further supports this, demonstrating that switching from car travel to active modes positively influences overall psychological well-being. These findings are corroborated by Avila-Palencia et al. (2018), who highlight the mental health benefits of bicycle use, such as reduced stress and loneliness. However, De Hartog et al. (2010) caution that transitioning from car to bicycle commuting is not without risks, although the overall health benefits of cycling outweigh the potential hazards.

The choice of transportation mode has been well-established as a significant factor influencing travel satisfaction and stress levels (Ettema et al., 2017). Research indicates that different modes of transportation can affect an individual's well-being in distinct ways. For example, active modes of transport, such as walking and cycling, have been associated with positive health outcomes and improved well-being, due to the physical activity involved (Martin et al., 2014). Conversely, passive modes of transport, such as driving and using public transportation, can lead to increased stress and reduced well-being, as a result of factors such as traffic congestion, delays, and lack of control over the travel environment (Gatersleben & Uzzell, 2007). Gatersleben and Uzzell (2007) also found that perceptions of the daily commute differed

across transportation modes, with drivers generally experiencing more stress than walkers, cyclists, and users of public transport.

General stress as well as symptoms of anxiety and depression are essential components of an individual's well-being and are influenced by various factors, including transportation modes, exercise, and goal fulfillment. Understanding the interplay of these factors on the overall travel experience is crucial, as it can inform urban planning and public policy aimed at promoting healthier and more sustainable transportation options (Buehler & Pucher, 2017; Chatterjee et. al., 2018). As the number of commuters continues to grow worldwide (Armstrong, 2021) and transportation infrastructure plays a critical role in urban development (Stromberg, 2015), this study aims to investigate the effects of active commuting as a transportation mode and future self-continuity on stress, depression, and anxiety symptomatology through a comprehensive two-group survey collection, separating conditions by active vs. inactive commuting.

The concept of present-future self-continuity—or future self-continuity (FSC)—is crucial in understanding these dynamics. FSC refers to how individuals perceive their future selves in relation to their current selves. A strong sense of FSC can influence one's motivation to engage in behaviors that promote long-term well-being, including the choice of healthier commute modes. The theory of self-enhancement and the principle of temporal discounting are pertinent here. Individuals with a higher degree of FSC are less likely to succumb to temporal discounting, wherein immediate rewards are favored over future benefits (Hershfield, 2011; Hershfield et al., 2012). As such, they may be more inclined to engage in active commuting, viewing it as beneficial for their future self. Self-enhancement theory posits that individuals are motivated to maintain a positive view of themselves, which can lead to adopting healthier behaviors like

active commuting, seen as self-improving (Taylor et al., 2000; Taylor & Armor, 1996; Taylor & Brown, 1988).

Considering these factors, a hypothesis emerges: A main effect will emerge between Future Self Continuity and Depression, Anxiety, and Stress, which will manifest as an inverse correlation. This suggests that individuals with a stronger connection to their future selves will experience lower levels of depression, anxiety, and stress. Additionally, two main effects are suggested between commute mode (active vs. inactive commuting), depression, anxiety, and stress, and future self-continuity. Active commuting, by promoting physical activity in participants and reducing exposure to stressful driving conditions, is hypothesized to be inversely associated with these mental health issues. And as future self-continuity promotes healthy behaviors, a greater future self-continuity is expected in active commuters. Lastly, an interaction is expected between these main effects. A stronger interaction between the main effects is expected among active commuters.

In conclusion, the psychological benefits of active commuting should not be overlooked when considering sustainable transportation options. As more cities invest in alternative commute infrastructure and promote cycling as an alternative mode of transport, the potential for improved mental health and well-being among the population is vast. Emphasizing the psychological advantages of active commuting can encourage more individuals to adopt this sustainable and healthy form of commuting, ultimately benefiting both individuals and the environment.

Method

Study Design

The study employs a cross-sectional design, which was strategically selected for its efficacy in examining the relationships between commuting habits, future self-continuity, and mental health at a single point in time through a simple survey. This design is advantageous for its capacity to gather cross-sectional slices of data across various populations, facilitating the analysis of correlations between variables without the need for prolonged observation inherent in longitudinal studies.

Participants & Data Collection

Participants for this study were exclusively recruited through Prolific's participant recruitment platform. The cohort comprised 114 non-at-risk adult Americans receiving $2 for their engagement. While the survey was designed to be completed in about 10 minutes, the average completion time was notably shorter at four minutes and twenty-five seconds (4:25), equating to an average hourly compensation of $27.17. Recruitment was conducted on a convenience basis, with Prolific disseminating surveys to its pool of candidates on a first-come, first-served model. However, Prolific's balanced sampling feature ensured a nearly equal representation of male and female participants, yielding a balanced dataset consisting of 57 individuals of each gender.

Strict inclusion and exclusion criteria were established to guarantee the integrity of the data. Participants were mandated to give informed consent and commit to meticulous engagement with the survey. Those unwilling to meet these requirements were asked to return

their participation slot. Respondents who completed the survey in under three minutes were deemed insufficiently engaged and, thus, were removed from the dataset. Additional grounds for exclusion included failing two or more out of five attention check questions, omitting answers to critical questions necessary for robust data analysis, and any indication of minimal effort. The final exclusion criteria removes outliers from the performed measures. Three participants met the exclusion criterium of scoring at least 2.5 standard deviations from the mean in the DASS-10 scale. These outlying statistics were removed from their applicable analyses, particularly only in analyses involving the DASS-10.

After enforcing these exclusion criteria, the sample size was reduced to 90 participants. The refined participant pool consisted of 40 men, 45 women, and 5 nonbinary participants, with an adjusted average survey completion time of six minutes and ten seconds (6:10).

Demographics

The participant demographic, before outlier exclusion and containing 50 men and 45 women, predominantly identifies as White, with 62 individuals, followed by 11 of Mixed ethnicity, and a tie between Black and Asian participants at 7 each. A minority of the cohort's ethnicity is categorized as 'Other' or has 'Expired' data. A significant majority, 86 participants, were born in the United States. The sample also includes individuals born in a diverse array of countries, with one participant each from Ethiopia, the Philippines, Nigeria, Italy, Poland, Mexico, and Venezuela. All participants are currently U.S. residents and hold American nationality.

In terms of language, English is the primary language for 87 participants, underscoring the U.S.-centric nature of the sample. Spanish is the first language for 4 participants, and there is

a small representation of other languages—Vietnamese, Tagalog-Filipino, Italian, and Chinese—each with one native speaker.

Regarding educational status, 44 participants are not currently enrolled as students while 16 are, indicating a mix of professional and student life stages within the group. The student status for 35 participants is marked as 'Expired,' suggesting a potential area for data recapture in future demographic assessments.

Regarding educational achievement, the largest segment of participants indicated they had completed high school as their highest level of education, with 41 individuals falling into this category. Associate degrees were held by 9 participants, while bachelor's degrees were reported by 31 individuals. A further 8 participants had obtained a master's degree, and 4 had achieved a doctorate or equivalent advanced degree.

The population contained a diverse body regarding socioeconomic status. The survey used annual income as a metric to categorize this feature. More than half of the population indicated a lower-class income range, with 25 participants reporting an annual income of less than $20,000, and 26 participants reporting an income between $20,001 and $40,000. A quarter of participants reported a middle-class income range, with 16 participants reporting an income of $40,001 to $60,000, and 8 participants reporting an income of $60,001 to $80,000. In the upper-class range, 8 participants reported making $80,001 to $100,000, and 9 participants reported earning over $100,001.

Measures and Instruments

Commuting Questionnaire

The Commuting Questionnaire is designed to gather data on individuals' commuting behaviors and related factors. Its purpose is to distinguish between active commuting, which involves physical activity such as walking or biking, and inactive commuting, which relies on vehicles like cars, buses, or trains. It operationalizes the variable of Commute Type by asking participants to categorize their typical commute as either active or inactive.

In addition to Commute Type, the questionnaire collects data on various potential moderating variables that could influence commuting behaviors. These include demographic information such as age, state of residence, gender, occupation, and education level. Attention checks are interspersed to ensure participant focus. Income range is queried, as an indicator of socioeconomic status. The questionnaire also inquires about the typical weather conditions during commuting, the intensity of physical activity involved, the average duration of the commute, and the type of terrain and area through which the participant commutes (urban, suburban, rural, or mixed). The questions pertaining to third variable analyses use a 5-point Likert scale. Participants' overall physical health, the quality of infrastructure along their commuting route, and the importance of reducing environmental impact in their choice of commuting method are also assessed using a 5-point Likert scale.

Future Self-Continuity Questionnaire

The Future Self-Continuity Questionnaire (FSCQ) is an instrument designed to assess the concept of future self-continuity (FSC), which refers to the sense of connection individuals feel with their future selves. This sense of continuity plays a crucial role in personal identity and has

implications for behavior, decision-making, and mental health. The primary goal of the FSCQ is to measure this construct through three dimensions: similarity to the future self, vividness of the future self, and positivity towards the future self.

The development of the FSCQ involved exploratory factor analysis (EFA) to select items and generate a potential factor model, followed by confirmatory factor analysis (CFA) to assess model fit across multiple independent adult samples. The final version of the FSCQ consists of 10 items, each rated on a scale from 1 to 6. The EFA identified three factors within the FSCQ corresponding to the theoretical underpinnings of FSC, aligning with Hershfield's postulations and theories in his 2011 research: similarity, vividness, and positivity (Hershfield, 2011). These factors were confirmed in subsequent CFAs, showing strong internal consistency and reliability. Additionally, the FSCQ demonstrated convergent, discriminant, and nomological validity, indicating it is a coherent measure that correlates appropriately with related constructs and distinct from unrelated ones (Sokol & Serper, 2020).

The questionnaire's development was driven by the need for a more robust assessment of FSC than previous single-item measures. The FSCQ provides a multi-dimensional approach, reflecting the complexity of the construct, and allows for the precise estimation of measurement error. The scale's psychometric properties were evaluated through rigorous statistical analysis, ensuring its reliability and validity for research purposes (Sokol & Serper, 2020). For the sake of brevity, and concomitantly to increase the internal reliability of the FSCQ, the questionnaire was truncated before its application herein. The three least reliable metrics were removed for the sake of this study. These appear as the first, second, and seventh in the FSCQ. The truncated edition of the FSCQ will be henceforth referred to as the FSCQ-T.

In summary, the FSCQ and FSCQ-T are psychometrically sound tools that provide a nuanced measure of FSC, capturing the degree to which individuals identify with their future selves across different dimensions. The FSCQ is a reliable and valid instrument, and its development is imperative to the quantification of future self-continuity in the near future.

Depression, Anxiety, and Stress Scale

The Depression, Anxiety, and Stress Scale (DASS) is a well-established instrument designed to measure the negative emotional states of depression, anxiety, and stress. The original DASS, designed by Lovibond and Lovibond in (1995), comprises three separate scales, each with 14 items that are grouped into smaller clusters of 2 to 5 related items. The Depression scale measures a range of symptoms including feelings of sadness, hopelessness, a sense of worthlessness, self-criticism, a lack of interest or involvement, inability to feel pleasure, and lethargy. The Anxiety scale evaluates physical signs of anxiety such as increased autonomic arousal, muscular effects, anxiety in specific situations, and the individual's personal feelings of anxiety. The Stress scale detects persistent arousal of a general nature, capturing difficulties in relaxing, a state of restlessness, a propensity to become disturbed/upset quickly, irritability, over-reactiveness, and a lack of patience. Participants rate the degree to which they have encountered these feelings in the last week using a four-point scale that measures the severity and frequency of these experiences. The total scores for the Depression, Anxiety, and Stress scales are derived by adding up the scores for their respective items (Halford & Frost, 2021; Lovibond & Lovibond, 1995).

Subsequently, to meet the needs of shorter and more efficient measures as the result of a changing landscape in data collection procedure, the DASS-21 was introduced. This 21-item

version, like the 42-item version, requires participants to reflect on the past week and rate the presence of the symptoms listed. Each item on the DASS-21 corresponds to one of three scales—Depression, Anxiety, or Stress—and is scored in the same manner as the original DASS. To compute the final score for each scale, the sum of the items is multiplied by two, which is then used to assess severity and provide percentile rankings.

Research on the DASS-10, a further condensed version of the scale, has shown it to be a reliable and valid measure for assessing depression, anxiety, and stress. The DASS-10 retains the core features of the longer scales, ensuring accurate assessment despite the reduction in items (Halford & Frost, 2021). The internal consistency coefficients for the DASS-10, based on a study conducted with 555 subjects, are .85 for depression, .81 for anxiety, and .80 for stress, reflecting a high degree of reliability.

Procedure

Upon entry into the study, participants are required to submit their unique Prolific participant ID for session tracking purposes. This ID serves as a pseudonym to maintain participant anonymity throughout the process. Following this, participants encounter the Informed Consent document, which articulates the objectives of the study, the voluntary nature of participation, and the confidentiality of the responses, ensuring ethical compliance. An Attention Agreement is also presented to reinforce the importance of diligent engagement with the survey content. Only participants who provide affirmative informed consent and acknowledge the attention agreement proceed to the main questionnaire.

The initial segment of the questionnaire is the Commuting Questionnaire, a tool specially devised for the purposes of this study. It asks participants to self-report their commuting habits,

distinguishing between active commuting (e.g., walking, cycling) and passive commuting (e.g., driving, public transport), and includes inquiries about the duration, frequency, and environmental context of their commutes, along with perceived physical health effects. This instrument is designed to capture a comprehensive profile of the participants' commuting patterns.

Following the Commuting Questionnaire, participants are presented with a modified version of the Future Self Continuity Questionnaire. The original questionnaire consists of ten items, but for the purposes of this study, it has been condensed to seven questions to streamline the survey-taking experience while still capturing the essence of the construct. These questions are designed to measure how individuals perceive their future selves in terms of vividness, similarity, and positivity, which are indicative of their future self-continuity.

Participants then proceed to the Depression, Anxiety, and Stress Scale-10 (DASS-10), a short-form version of the DASS-21, itself a reduced version of the 42-item DASS. The DASS-10 has been validated as a reliable measure for quickly assessing mental health outcomes, particularly depression, anxiety, and stress levels. Each of these three components is scored separately, and then combined to form an overall psychological health score.

The final part of the survey comprises a demographic questionnaire intended to fill in any gaps or correct any discrepancies in Prolific's demographic data. The inclusion of this section is critical for measuring the representativeness of our sample and for controlling for demographic variables in our analyses.

In addition to the primary questionnaires, the survey incorporates five attention check questions. These are interspersed throughout the survey: two within the Commuting Questionnaire, two in the DASS-10 section, and one in the demographic section. These checks

are intended to verify that participants are maintaining adequate attention throughout the survey, which is vital for ensuring the quality and reliability of the data collected.

Upon completion of the survey, participants are shown a debrief statement that provides a summary of the study's purpose and the importance of their contribution. They are then redirected back to Prolific to verify their completion of the survey.

Overview & Rationale

This methodological framework, with its cross-sectional design, presents a snapshot of the interrelationships among key psychological constructs and daily behaviors. The current study provides an analysis of the referenced variables in a single point in time, although these variables do undergo complex longitudinal interactions. The results presented herein offer only a cross-sectional analysis due to the time constraints and limited resources of the researchers. As the researchers had only several months to complete this report upon collection of the data, an online survey approach was necessary for the diligent and thorough analysis of the dataset. These variables, as understood through the chosen cross-sectional design, are uncontrolled, self-assessed, and are likely variable due to external factors.

While this design is advantageous under current time and budgetary limitations, longitudinal studies could provide a more in-depth understanding of the causal and temporal dynamics between commuting habits, future self-continuity, and mental health. Longitudinal research is better suited to unravel the directionality of these relationships, especially relationships pertaining to commute mode, and observe how they unfold over time. There is a need for such analyses in the literature, as they can illuminate the long-term effects and potential

shifts in these constructs. These limitations and suggestions for more thorough research shall be propounded in the forthcoming discussion section.

Results

Data Analysis

Descriptive Analysis

The following descriptive statistics provide a quantitative summary of the scores from the Truncated Future Self-Continuity Questionnaire (FSCQ-T) and the Depression, Anxiety, and Stress Scale-10 (DASS-10), with and without outlying participants.

For the FSCQ-T, all 93 participants have valid scores with a mean (average) score of 21.7. This score is close to the median score of 22, indicating that participants experience an equally distributed strength of future self-continuity on both sides of the mean. The standard deviation, a measure of data spread, is 4.35, which suggests that participants experience a moderate amount of variation in scores, indicating a moderate inclination toward an intermediate experience of self-continuity among participants. The scores range from a minimum of 11 to a maximum of 31, showing that the average participant score near perfectly in the middle of the scale, moderate intensity of future self-continuity. The absolute minimum of the scale is 6, and the absolute maximum is 36.

Descriptives

	FSC SCORE	DASS SCORE	DASS SCORE (NO OUTLIERS)
N	93	93	90
Missing	0	0	3
Mean	21.7	7.52	6.88
Median	22	6	6.00
Standard deviation	4.35	6.47	5.53
Minimum	11	0	0
Maximum	31	27	21

The DASS-10 scores, with all 93 respondents considered, have a lower mean score of 7.52, which reflects a lower level of depression, anxiety, and stress symptoms in the sample compared to the mean FSCQ-T score. This aligns with incidence rates of the three measured traits in the U.S. population, as the DASS scores responses between 0-9, 0-7, and 0-14 to be

"normal" scores for depression, anxiety, and stress respectively (Lovibond & Lovibond, 1995). The median that participants score for the DASS-10 is 6, and the standard deviation of participants is 6.47, which demonstrates that participants experience a skew toward lower self-reported symptomatologies of stress, depression, and anxiety—a result representative of the U.S. population (Lovibond & Lovibond, 1995). The variation in the reported severity of symptoms suggests a diverse range of experiences among the sample population concerning the traits being measured. The DASS-10 scores range from 0 to 27, with a true maximum of 30.

When outliers are removed from the DASS-10 scores, the number of respondents considered drops to 90. The mean score without outliers is 6.88, which is lower than the mean with all responses. All three outlying participants had higher scores that slightly elevated the overall mean. The median of 6.00 is consistent with the previously apparent skew towards symptoms of anxiety, stress, and depression, as it is less than the mean. The standard deviation without outliers is 5.53, obviously indicating that the outliers affected the variability and overall range of the self-reported symptoms.

In conclusion, the FSCQ-T data reflects a moderate, evenly distributed sense of future self-continuity, while the DASS-10 data, both with and without outliers, indicates a generally lower level of depression, anxiety, and stress symptoms, aligning with national averages. The variation in responses, particularly in the DASS-10 scores, highlights the diverse range of experiences in these mental health aspects within the population.

Reliability Analysis

For the DASS-10 scale, the overall Cronbach's alpha is 0.898, suggesting a high level of internal consistency and indicating that the scale is a reliable measure of the constructs it intends

to assess. The individual item analysis, which considers the alpha if an item is dropped, shows that no single item disproportionately affects the scale's reliability. The alphas range from 0.879 to 0.906 when each item is potentially removed, which indicates that each item on the DASS-10 contributes to the scale's overall reliability without any single item being critical for maintaining it.

Scale Reliability Statistics

	Mean	SD	Cronbach's α
scale	3.62	0.724	0.745

[3]

Item Reliability Statistics

			If item dropped
	Mean	SD	Cronbach's α
FSCQ Q3	3.86	1.176	0.742
FSCQ Q4	4.20	1.079	0.732
FSCQ Q5	3.14	0.985	0.698
FSCQ Q6	3.17	1.070	0.748
FSCQ Q8	3.65	1.100	0.657
FSCQ Q10	3.68	1.134	0.664

On the other hand, the FSCQ-T scale has an overall Cronbach's alpha of 0.745, which is above the commonly accepted threshold of 0.7 for a reliable scale but lower than that of the DASS-10. This alpha is measured after truncating the original questionnaire, which involved removing questions 1, 2, and 7 due to their low reliability scores. This suggests that while the FSCQ-T is a reliable measure, it may not be as internally consistent as the DASS-10. The item analysis reveals that certain items (Q5 and Q8) would increase the scale's reliability if removed, with their respective alphas being 0.698 and 0.657. Additionally, the removal of questions 1, 2, and 7 already increase the reliability of the questionnaire after their removal. This suggests that these items may not align as well with the underlying construct as the other items do.

Scale Reliability Statistics

	Mean	SD	Cronbach's α
scale	0.757	0.652	0.898

[3]

Item Reliability Statistics

			If item dropped
	Mean	SD	Cronbach's α
DASS Q2	1.108	0.949	0.888
DASS Q3	0.946	0.913	0.879
DASS Q4	0.710	0.904	0.906
DASS Q5	0.785	0.998	0.883
DASS Q6	0.398	0.739	0.885
DASS Q7	0.613	0.781	0.888
DASS Q8	0.634	0.857	0.882
DASS Q9	1.022	0.897	0.884
DASS Q10	0.602	0.836	0.882

In summary, both scales demonstrate acceptable levels of reliability. The DASS-10 exhibits higher reliability and consistency across items, while the FSCQ-T and FSCQ, although reliable, might benefit from a review of certain items to potentially improve its internal consistency.

Main Analysis

To comprehensively evaluate the hypotheses of the present study, a series of statistical tests will be administered on the collected data. Analyses of the effects will be performed using Jamovi, a popular open-source statistical software recently adopted en masse by Bard College students and professors, succeeding the previous expensive and closed-source statistical tool SPSS. Despite its limited capabilities in comparison to SPSS, Jamovi is still capable of a variety of complex statistical procedures that satisfy the requirements of the present study's analysis.

A linear regression will be used to examine the relationship between Future Self-Continuity (FSC) and Depression, Anxiety, and Stress Scale (DASS) scores. The correlation method is suitable for determining the strength and direction of the relationship between these two continuous variables.

An independent samples t-test will be employed to compare the mean scores of the DASS-10 and FSCQ-T between two groups of commuters (active and inactive). An independent samples t-test is ideal for comparing the means between two independent groups on the same continuous, normally distributed variables.

Linear Regression Between FSCQ-T and DASS-10

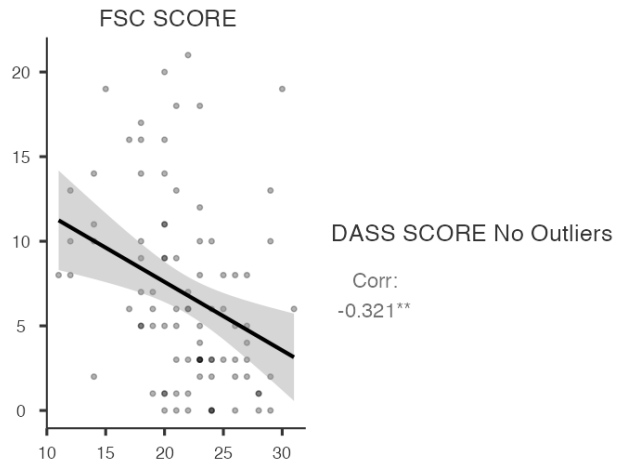
A linear regression was conducted to examine the relationship between Truncated Future Self-Continuity (FSCQ-T) and Depression, Anxiety, and Stress Scale-10 (DASS-10) scores. The results indicated a significant negative correlation between DASS-10 scores and FSCQ-T scores, with a Pearson's r value of -0.321 and a p-value of 0.001 (r = -0.321, p = 0.001). This suggests that as FSCQ-T scores increase, indicating a stronger connection with one's future self, DASS-10 scores tend to decrease, signifying lower levels of depression, anxiety, and stress. This supports the hypothesis that a stronger sense of future self-continuity is associated with better mental health outcomes.

Model Fit Measures

Model	R	R^2
1	0.321	0.103

Model Coefficients - DASS SCORE No Outliers

			95% Confidence Interval			
Predictor	Estimate	SE	Lower	Upper	t	p
Intercept	15.688	2.825	10.073	21.303	5.55	<.001
FSC SCORE	–0.405	0.127	–0.657	–0.152	–3.18	0.002



T-tests of Commute Type Between FSCQ-T and DASS-10

The comparison of active and inactive commuters was analyzed using a two-group t-test against DASS-10 and FSCQ-T scores, where group 1 represents active commuters and group 2 represents inactive commuters.

Independent Samples T-Test

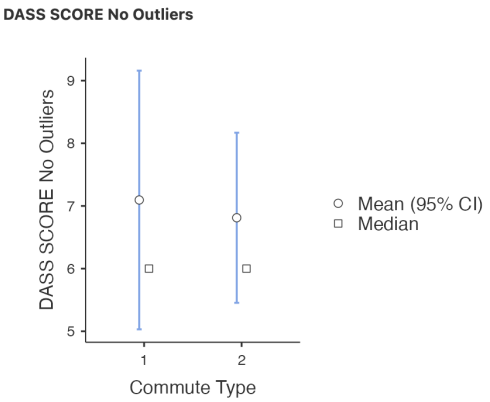
		Statistic	df	p
DASS SCORE No Outliers	Student's t	0.205	88.0	0.838
FSC SCORE	Student's t	–0.189	91.0	0.851

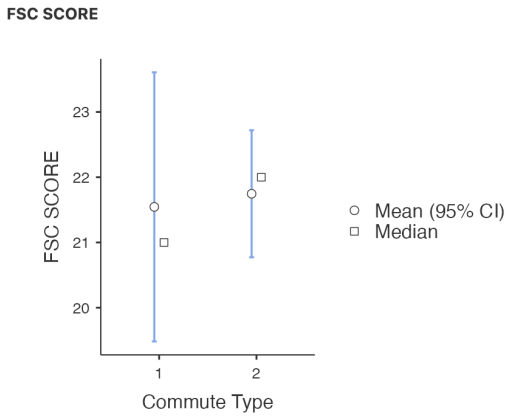
Note. H_a $\mu_1 \neq \mu_2$

Group Descriptives

	Group	N	Mean	Median	SD	SE
DASS SCORE No Outliers	1	21	7.10	6.00	4.83	1.05
	2	69	6.81	6.00	5.75	0.693
FSC SCORE	1	22	21.55	21.00	4.94	1.05
	2	71	21.75	22.00	4.18	0.497

For DASS-10 scores, the t-test revealed a t-statistic of 0.205, with a p-value of 0.838 ($t = 0.205$, $p = 0.838$), indicating no significant difference in DASS scores between active and inactive commuters. This suggests that the type of commute does not significantly impact the stress, depression, and anxiety of the participants, or vice versa. DASS-10 scores were lower among inactive commuters, however the difference is negligible considering the lack of statistical significance in this analysis.





For FSCQ-T scores, the t-test revealed a t-statistic of -0.189, with a p-value of 0.851 ($t = -0.189$, $p = 0.851$), indicating no significant difference in FSCQ-T scores between active and inactive commuters. This suggests that the self-continuity of the participants does not significantly impact their choice of commute mode, or vice versa. FSCQ-T scores were higher among inactive commuters, however the difference is negligible considering the lack of statistical significance in this analysis.

No significant interaction was found between commute type and the relationship between FSCQ-T and DASS-10 scores. This indicates that the strength of the association between an individual's future self-continuity and their mental health does not vary significantly depending on whether they are active or inactive commuters.

Discussion

Relevance

The present study aims to build upon literature in the field of self-continuity and motivation that has only recently been undertaken, exploring the feasibility of future self-continuity as a self-regulatory and motivational force, and deliberating on its interactions with commuting patterns in American populations. This paper has achieved this through the exploration of relationships between future self-continuity (FSC) and mental health as measured by the Depression, Anxiety, and Stress Scale (DASS), and how these may be affected by commuting habits. This exploration is situated at the intersection of psychological well-being, urban planning, and public health policy.

Commuting, a ubiquitous aspect of modern life, has been identified as an area of interest due to its pervasive nature and potential implications for individuals' mental health and daily functioning. By integrating the construct of FSC within the context of daily commuting, the study seeks to illuminate how individuals' perceptions of their future selves may influence their choices and experiences in the present, particularly in relation to their commuting behaviors. The exploration is rooted in the understanding that the daily commute is not just a physical transition from one place to another, but also a psychological journey that can affect mood, stress levels, and overall mental health. In situating the research within American populations, the study acknowledges the diversity and complexity of commuting experiences in the United States, shaped by a multitude of factors including geographic, economic, and social variables. Although this data was not analyzed in the results, the data on these variables has been collected and remains available through this present study. As such, the research has the potential to offer insights that are highly relevant to a wide range of stakeholders, including urban planners, public

health officials, and individuals striving to optimize their daily routines for improved mental health outcomes.

The research addresses a relatively underexplored area by investigating the relationship between future self-continuity and mental health, and how these are influenced by commuting patterns. This novel approach provides new insights into the psychological impacts of daily activities and contributes to the broader discourse on self-identity and motivation, and inspires future research into the nature of commuting as a motivational and health-centric aspect of daily life.

The study utilizes robust and well-established psychometric instruments, crucial for the accurate and consistent measurement of mental health constructs and self-continuity. The Depression, Anxiety, and Stress Scale-10 (DASS-10) is particularly advantageous for the online survey nature of this research. The DASS-10, a condensed form of the longer DASS, is validated as a reliable measure, enabling quick assessment of mental health outcomes, particularly depression, anxiety, and stress levels. Its shortened form is beneficial for online administration, reducing participant fatigue and maintaining engagement without compromising the scale's psychometric properties. This is especially relevant as online surveys necessitate brevity and heightened focus from participants who may be more prone to distractions and boredom than in a controlled testing environment. The internal consistency of the DASS-10, indicated by high Cronbach's alpha values across its subscales, assures researchers of its reliability despite the reduction in items (Halford & Frost, 2021).

Additionally, the study utilizes the Truncated Future Self-Continuity Questionnaire (FSCQ-T), a modified version of the FSCQ, which reflects a methodological strength in its brevity while still capturing the essence of the construct. The original FSCQ by Sokol & Serper

(2020) was purposefully truncated to enhance the survey-taking experience, which is an essential consideration in online research contexts where participant attention spans are limited (Sokol & Serper, 2020). The truncation involved removing the three least reliable metrics from the original questionnaire, thus increasing the internal reliability of the FSCQ-T. This methodological decision was guided by a reliability analysis, ensuring that the most representative and reliable items were retained. This selection process enhances the validity of the findings, as the FSCQ-T remains a psychometrically sound tool, providing a nuanced measure of FSC under the three categories identified by Hershfield (Hershfield, 2011; Sokol & Serper, 2020).

By recruiting participants through a platform like Prolific, the study benefits from a diverse cohort, which adds to the generalizability of the findings across different demographics within the American population. Although performing in-person interviews on the Bard College campus may have offered greater quality and deliberation in respondent's submissions, this approach would have significantly limited the size of the sample due to the constraints of having only one researcher available to perform the interviews. The time-intensive nature of one-on-one interviews would have drastically reduced the number of participants that could be feasibly interviewed within the project's timeframe, limiting the study's scope and the statistical power of the findings. In contrast, the use of an online platform such as Prolific allowed for concomitant data collection from a larger number of participants, enhancing the study's efficiency and the robustness of the data. This approach not only mitigates the selection bias inherent in campus-based samples, which typically consist of a younger, more educated demographic (and at Bard, a greater white majority), but also captures a wider array of commuting experiences and perspectives that are more indicative of the general population. Moreover, the online method

enables the inclusion of participants who might be otherwise unreachable due to distance or mobility constraints, ensuring a more inclusive and comprehensive dataset.

The study also excels in its clear and comprehensive account of its methodology, including the operationalization of its measures, survey flow, participant exclusion, and data collection processes. This transparency is crucial to the reproducibility of research, which acts as a cornerstone of scientific inquiry in modern academia.

Limitations

Despite the several strengths of this present study, it is important to acknowledge that the scope and design of the study were not without limitations. These limitations significantly impact the extent to which the findings can be generalized and applied. It is crucial to consider how the limitations of this study may influence the undertaken procedure of the study and its consequential results.

External Validity

Although the participants were collected through Prolific, a comprehensive online recruitment program, they were not screened to represent a generalizable sample. The participant demographics, provided by prolific and collected through the commuting questionnaire, proves a close resemblance to a U.S. population. However, due to financial limitations and the prioritization of sample size, gender was the only controlled demographic during recruitment. This poses risk to the external validity of the study, as the sample population fails to align appropriately with the national and international populations in several key demographics, including socioeconomic status and race and ethnicity. The present study tends to overrepresent

white participants and underrepresent black and hispanic populations in comparison to the U.S. demographic. Additionally, the socioeconomic status of the study's population does not accurately reflect that of the United States. It overrepresents individuals with annual incomes below $40,000 while underrepresenting those in the middle and upper classes. This disparity is likely attributable to the study's recruitment method. As Prolific predominantly motivates participation in experiments with financial incentives, it tends to deter middle- and upper-class individuals who have more substantial primary income sources.

Cross-sectional Design

The cross-sectional design of the study presents a significant limitation. This design was chosen due to limitations on the researchers, including time, funding, staff, and experience constraints. Unlike a longitudinal design, which would be more apt for tracking changes over time, the cross-sectional approach only provides a snapshot of the phenomena under study. This restricts the ability to draw causal inferences or observe how variables like commute type and self-continuity impact motivation and mental health longitudinally. Commuting patterns and their impacts on mental health and FSC are likely influenced by a range of dynamic life events, such as career changes, relocation, or significant life transitions. A cross-sectional study cannot capture these nuances, which might play a critical role in shaping the study's key variables. A longitudinal design would have also allowed for the observation of changes and trends over time in the observed variables (commute type; future self-continuity; depression, anxiety, and stress symptomatology). This temporal perspective is crucial for understanding the evolution of these variables and their interrelationships. Furthermore, the ability to infer causality from the observed correlations is significantly hampered in a cross-sectional study. Without observing

changes over time and controlling for other variables, it's challenging to ascertain whether factors like commute type influence mental health and FSC, or if these relationships are the result of other underlying variables.

Observational Design

Additional to the limitations of a cross-sectional design, the study's observational nature accompanies an inability to manipulate the independent variables. This is due to its reliance on self-reported data for commute type, and it limits the strength of causal conclusions that can be drawn. In a longitudinal study, manipulating commuting behaviors could yield more definitive insights into the causal relationships between commuting types, future self-continuity, and mental health. This methodological choice means that the study can identify correlations but cannot conclusively determine whether and how commute type directly influences FSC or mental health outcomes. This lack of control over the independent variables fail to account for other factors that could possibly influence both commuting behaviors and mental health. This could lead to confounding effects, where the observed relationship is not due to the variables of interest but to these uncontrolled factors.

Factors of Commuting

Commuting, a multifaceted and integral aspect of daily life for many individuals, is influenced by a myriad of factors that extend beyond the simple binary of active versus inactive modes. This complexity, however, was not fully captured in the study due to limitations in time and resources. Many key aspects contribute to the complexity of commuting, as supported by existing literature, but they were not controlled for in the present study.

Environmental factors play a significant role on travel-related mood. Commuting experiences are significantly impacted by variables such as weather conditions and season. Ettema et al. (2017) underscore the influence of these environmental factors on travel satisfaction and stress levels, highlighting how they can shape the overall commuting experience. The study "Season and Weather Effects on Travel-Related Mood and Travel Satisfaction" explores the impact of seasonal and weather conditions on mood and travel satisfaction (Ettema et al., 2017). The methodology involved collecting data from 562 morning commutes to work by 363 randomly sampled individuals in three Swedish cities. The key findings include significant effects of weather conditions (temperature, precipitation, sunshine, and wind speed) on travel-related mood and satisfaction. Temperature was found to influence mood positively, while wind speed increased activation for public transport users. Surprisingly, sunshine led to a more negative mood for cyclists and pedestrians. Regarding travel satisfaction, sunshine and higher temperatures generally increased relaxation during travel, except for cycling and walking. Rain and snow, on the other hand, led to higher perceived quality of travel (Ettema et al., 2017).

Commute duration, be it distance or time, constitutes another critical stitch in the tapestry of commuting experience. Not only does it influence the mental and physical exertion associated with travel but it also shapes the daily rhythm of individuals' lives. Longer commutes can encroach upon personal time, leading to increased stress and reduced work-life balance. Conversely, shorter commutes can enhance overall satisfaction and well-being. The interplay between commute duration and mode of transportation also holds significant implications. For instance, active commuting methods like walking or cycling, though potentially longer in duration, can offer health benefits and a sense of environmental contribution. On the other hand, longer durations in passive modes, such as driving or public transit, might contribute to sedentary

behaviors and associated health risks. A study by Mytton et. al. sought to asses active commuting, specifically cycling and walking to work, on various aspects of wellbeing. The research models were adjusted for various factors, including home to work distance. The study found that those who maintained cycle commuting reported lower sickness absence and higher mental wellbeing scores (MCS-8) compared to those who did not cycle to work. This study also recognizes the importance of longitudinal design in commute research, which is crucial for building a case for causal associations between active commuting and wellbeing (Mytton et al., 2016). The unexpected insignificance in the association between walking and physical and mental well-being is a prime example of the significant effects of commute duration. The authors state that the lack of significant findings for walking to work was unexpected and not entirely explainable by many non-walkers cycling to work. The average weekly duration of walking was relatively low, and the intensity of physical activity (walking being lower intensity than cycling) might be a crucial determinant of health effects. It's possible that the average 'dose' of walking to work was too low to impact wellbeing and sickness absence (Mytton et al., 2016). This finding underscores the importance of controlling for commute duration in active commuting.

Socioeconomic status and modal availability are other confounding variables in commuting that must be controlled for. Socioeconomic factors play a crucial role in determining commuting choices and experiences. Socioeconomic status significantly influences commuting decisions and experiences. It determines individuals' access to various transportation modes and the quality of their commuting experiences. People from higher socioeconomic backgrounds often have more choices in their mode of transport and may opt for more comfortable or efficient means. In contrast, those from lower socioeconomic backgrounds may have limited options, relying on public transport or non-motorized forms like walking or cycling, which can be

influenced by factors like urban planning, public infrastructure, and economic policies (Avila-Palencia et al., 2018; Ding et al., 2014; Martin et al., 2014).

Self-Enhancement as a Confounding Variable

The relationship between Future Self-Continuity (FSC) and the symptomatology of depression, anxiety, and stress is potentially confounded by the phenomenon of self-enhancement. The concept of self-enhancement, as previously addressed, involves an individual's inclination to maintain a positively skewed view of oneself, which can lead to distorted perceptions of personal abilities and characteristics. Individuals that score highly in self-enhancement show a tendency to report lower levels of depression, anxiety, and stress. This is due to their tendency to view themselves and their circumstances in a more positive light than what might be objectively warranted. Taylor & Brown's (1988) pioneering work in the study of self-enhancement as an adaptive trait shows that these distortions, termed "positive illusions," play a critical role in fostering and maintaining mental health, such as self-care, contentment, and productive work.

Taylor & Brown (1988) also note that self-enhancement also involves unrealistic optimism about the future. Hal Hershfield, a lead researcher in the field of future self-continuity, posits that future self-continuity should be measured via three distinct metrics: similarity, vividness, and positivity. Positivity, in this case, was operationalized by Sokol & Serper (2020) in their Future Self Continuity Questionnaire, which contains questions pertaining to one's self-assessed future self-positivity. The questions read as follows: "Do you like what you will be like 10 years from now?", "Do you like what your personality will probably be like 10 years from now?", "Do you like what your actions will probably be like 10 years from now?" (Sokol &

Serper, 2020, p. 3). Hershfield supports the use of positivity as a measure of self-continuity. In his 2011 study, he recognizes the potential effect of self-enhancement on the measurement of positivity, stating that "most healthy adults have a bias toward seeing themselves improving over time. Indeed, participants … seemingly held positive opinions of their future selves: both liking and caring variables were positively skewed and neither exhibited substantial variance," (Hershfield, 2011, p. 9-10). Despite this observation, Hershfield, as well as Sokol and Serper (2020), fail to recognize the interference that self-enhancement may employ in measuring future self-continuity against mood disorders.

Self-enhancement is known to have reductionary effects on symptoms of anxiety, depression, and stress through positive illusions (Taylor & Brown, 1988). Individuals might report lower levels of depression, anxiety, and stress because their positive illusions buffer them against negative self-perceptions and mental health symptoms. This raises concerns about the interpretation of the negative correlation found between FSCQ-T scores and mental health outcomes, suggesting a need for more nuanced measures that can differentiate between genuine future self-continuity and self-enhancement bias.

Future Steps

While the present study has proven to be insightful, it is burdened with significant limitations that past research has executed efficiently in separate contexts, and that future research in studying active behaviors and motivation should consider.

External Validity

Enhancing external validity through a more diverse sample would help generalize our findings across different populations. Our study's external validity is limited by the budget constraints and recruitment tools available to the researchers. Although our population represented an array of participants from diverse environments of the United States, it failed to represent a generalizable sample in socioeconomic and race factors. Future research should aim to include a broader spectrum of participants, encompassing various age groups, socioeconomic backgrounds, and ethnicities. Additionally, recruiting participants using more stringent and thorough criteria on urban and rural settings can offer insights into how commuting impacts differ across diverse environments. This approach would help in understanding the universal and unique aspects of commuting experiences across different populations. Some factors that are relevant in this context include the type and quality of public transportation available, the infrastructure for walking or cycling, and the average commuting distances in different regions. Urban areas often have more public transportation options but may also involve longer commutes due to traffic congestion, while rural areas might have limited public transportation, necessitating reliance on personal vehicles.

Longitudinal Design

Additionally, adopting a longitudinal study design could provide insights into the temporal dynamics of commuting behaviors and their impacts on mental health and self-continuity. Longitudinal data is essential for understanding the dynamic nature of these variables, especially the complex and multifaceted role of commuting. These variables are heavily influenced by life events and external factors that cross-sectonal designs cannot capture.

This design allows for observing trends over time, offering a temporal perspective for understanding the evolution and interrelationships of these variables. This design also offers a more effective model to infer causality, as longitudinal designs can control for other factors that might influence both commuting behaviors and mental health, reducing the likelihood of confounding effects. Furthermore, this approach is better suited to unravel the directionality of the relationships between commuting habits, FSC, and mental health, in how these relationships unfold over time and their long-term effects.

Objective Measures

Furthermore, in future research on FSC, it is imperative to integrate objective measures alongside self-assessment measures such as the FSCQ. Traditionally, Hershfield's studies employed innovative objective operationalizations like temporal discounting tasks, where participants chose between immediate gains and delayed consistent gains, enabling the calculation of a discounting rate ('k'). This rate quantified an individual's propensity to prioritize immediate rewards over future benefits, providing a direct insight into their perception of their future selves (Ersner-Hershfield et al., 2009). By combining these objective measures with self-assessment tasks, researchers would garner a more nuanced and multidimensional understanding of how participants relate to themselves in the future. This dual approach would enable researchers to assess both trends in conscious self-perception and implicit behavioral tendencies. Objective measures should be considered for commuting behavior operationalization as well. Multiple studies and reviews have categorized active and inactive commuting by subcategorizing the unique methods one uses to travel. For instance, Avila-Palencia et al. (2018) used transport mode measures from baseline and final questionnaires as exposure variables to

assess the association between transport mode use and various health outcomes, including self-perceived health, perceived stress, mental health, vitality, loneliness, and social contact. The study utilized a mixed approach, employing both single transport mode models, where only one mode was assessed at a time, and multiple transport mode models, where all different transport modes were included. This approach allowed for the assessment of behaviors involving the use of multiple transport modes (Avila-Palencia et al., 2018)

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Appendices

Appendix A: Questionnaire

Prolific ID Entry Block

Please enter the Prolific ID provided to you.

[Open-ended response]

Informed Consent Block

Informed Consent:

This document provides an overview of a research study conducted by a senior Psychology undergraduate at Bard College aimed at investigating the connections between active commuting habits and future self continuity. Bicycling and other active modes of transportation have been identified as physical activities that can yield positive mental health benefits in numerous ways. The primary objective of this study is to explore the role of future self continuity in enhancing these positive effects, particularly in terms of perceived stress, anxiety, and depression.

As a participant, you will be asked to complete a questionnaire designed to collect pertinent data. The questionnaire should take no more than fifteen minutes to complete. This will involve responding to personal queries concerning your mental health characteristics, general wellbeing, symptoms related to depression and anxiety, and experiences of stress. We caution that these questions may evoke strong emotions or recall of distressing memories, as they require introspective reflection on your mental state. We understand that the topics covered in this

questionnaire can be sensitive, and we prioritize your comfort and well-being throughout this study. Therefore, if at any point you encounter a question that you find too uncomfortable or distressing to answer, we want to emphasize that you have the complete freedom to skip that question.

We encourage you to prioritize your mental and emotional well-being at all times while participating in this study. We ask, however, that the survey be completed to the best of your ability. Please note that your participation in this study is entirely voluntary. You may choose not to participate without any repercussions, and there will be no penalty or loss of benefits to which you are entitled. Moreover, you have the right to withdraw from the study at any point in time without any negative consequences. Upon completing the study, you will be compensated for your time.

We want to assure you that your privacy is of utmost importance to us. All responses will be collected and analyzed anonymously, and no identifying information will be saved to the dataset. Your individual responses will be anonymous at every stage of the study. Data may be archived and publicly accessible at online repositories such as the Open Science Framework. No identifying information will be included in such a posting. Due to the risk involved with this study, a resource for addressing mental health concerns is offered below and at the end of the study. We encourage that you access this resource in the case of crisis onset by participation in this study or otherwise.

Suicide and Crisis Lifeline: 998

If you have any questions regarding the nature of the study or participants' rights, please contact the undergraduate researcher at mg8765@bard.edu, the Bard College IRB at irb@bard.edu, or the faculty supervisor at lane@bard.edu.

1. I am at least 18 years of age and I understand the procedure and risks associated with the current study and provide my informed consent to proceed.

Ineligibility Block

Thank you for your interest in taking this survey! Unfortunately, you are not eligible to participate in this study.

Upon continuing, you will be redirected to Prolific. If you are prompted to log in, please do so. After you are redirected, please complete all instructions provided by Prolific before closing the window.

Thank you!

Attention Commitment Block

Attention Commitment:

Thank you for participating in this survey. Your honest and attentive responses are crucial for the accuracy and success of our research. Before you proceed, we ask you to commit to providing thoughtful and consistent answers throughout the entirety of the questionnaire. It's important to us, and to the validity of the study, that each participant is fully engaged and not rushing through the questions.

By continuing with this survey, you agree to approach each question with care, taking the necessary time to read and understand each one. Your commitment to attentiveness not only

respects the effort behind this research but also ensures that your voice and experiences are represented accurately. If you agree to these terms, please proceed. If you feel you cannot dedicate the necessary attention at this time, we kindly ask you to return to the survey when you can provide focused and deliberate responses.

1. I commit to providing thoughtful and attentive responses throughout this survey, understanding the importance of my accuracy and engagement for the validity of the research.

Commute Questionnaire Block

Active commuting involves using physical activity, like walking or biking, to get to destinations such as work or school. It's a way to incorporate exercise into daily routines. Inactive commuting, on the other hand, means relying on vehicles like cars, buses, or trains where minimal physical effort is needed. Your choice between using active methods of transport like walking and biking or using a vehicle determines if you're an active or inactive commuter.

Based on the information above, would you describe your typical commute behavior to be active or inactive?

1. Active
2. Inactive

On most of your commuting days, how would you describe the typical weather conditions?

1. Sunny/Clear
2. Overcast/Cloudy
3. Rainy/Wet

4. Snowy/Icy
5. Windy

How would you describe the intensity of your regular physical activities during commuting? To make sure you are focused, please select the option "Slightly intense".

1. Very intense
2. Intense
3. Moderately intense
4. Slightly intense
5. Not at all intense

How long is your average one-way commute?

1. Less than 10 minutes
2. 10-20 minutes
3. 21-30 minutes
4. 31-40 minutes
5. 41-50 minutes
6. 51-60 minutes
7. More than 1 hour

Which of the following best describes the area you primarily commute through? Please select all that apply.

1. Urban/City Center

2. Suburban
3. Rural/Countryside

How would you describe the terrain of your typical commute? Please select all that apply.

1. Mostly flat
2. Moderate hills
3. Steep hills/mountains

How would you rate your overall physical health? [Reverse-coded]

1. Excellent
2. Good
3. Average
4. Poor
5. Terrible

Please choose the option "Very important" to confirm you're reading carefully.

1. Extremely important
2. Very important
3. Moderately important
4. Slightly important
5. Not at all important

How would you rate the availability and condition of infrastructure (e.g., sidewalks, bike lanes, public transit facilities) in your commuting route? [Reverse-coded]

1. Excellent
2. Good
3. Average
4. Poor
5. Terrible

How important is reducing your environmental impact to you when choosing a commuting method? [Reverse-coded]

1. Extremely important
2. Very important
3. Moderately important
4. Slightly important
5. Not at all important

FSCQ-T Block

The following questions pertain to how you imagine yourself to be in ten years. Please read each question and answer as truthfully as you can. Do not spend too much time on any one question.

How similar is your personality now to what it will be like 10 years from now?

1. Completely different
2. Somewhat different
3. A little different
4. Similar
5. Very similar
6. Exactly the same

How similar are your values now to what they will be like 10 years from now?

1. Completely different
2. Somewhat different
3. A little different
4. Similar
5. Very similar
6. Exactly the same

How vividly can you imagine what you will be like in 10 years from now?

1. Not at all
2. Not very well
3. Somewhat
4. Pretty well
5. Very Strongly
6. Perfectly

How vividly can you imagine what you will look like in 10 years from now?

1. Not at all
2. Not very well
3. Somewhat
4. Pretty well
5. Very strongly
6. Perfectly

Do you like what you will be like 10 years from now?

1. Not at all
2. Not very well
3. Somewhat
4. Pretty well
5. Very Strongly
6. Perfectly

Do you like what your actions will probably be like 10 years from now?

1. Not at all
2. Not very well
3. Somewhat
4. Pretty well
5. Very Strongly

6. Perfectly

DASS Block

Please read each statement and select a a response which indicates how much the statement applied to you over the PAST WEEK. There are no right or wrong answers. Do not spend too much time on any statement.

I felt I was close to panic.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I found it difficult to work up the initiative to do things.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I felt down hearted and blue.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time

4. Applied to me very much, or most of the time

I was intolerant of anything that kept me from getting on with what I was doing.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I felt I had nothing to look forward to.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I had trouble falling sleep (please select option 2 to ensure you're paying attention).

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I felt scared without any good reason.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time

3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I tended to overreact to situations.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I was worried about situations in which I might panic and make a fool of myself.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I felt unsteady and dizzy. For this statement, please select

the third option.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I found it difficult to relax.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

I couldn't seem to experience any positive feelings at all.

1. Did not apply to me at all
2. Applied to me to some degree, or a good part of the time
3. Applied to me to a considerable degree, or a good part of the time
4. Applied to me very much, or most of the time

Demographic Questionnaire Block

Please answer the following questions as truthfully as possible.

What is your age?

1. 18-24
2. 25-34
3. 35-44
4. 45-54
5. 55-64
6. 65+

What is your gender?

1. Male
2. Female
3. Non-binary / third gender
4. Prefer not to say

In what state/territory do you live?

[Open-ended response]

What is your occupation?

[Open-ended response]

What is your education level?

1. High School
2. Associate's Degree
3. Bachelor's Degree
4. Master's Degree
5. Doctorate or Higher

To ensure you're focused, please answer "Often".

1. Always
2. Often
3. Sometimes

4. Rarely
5. Never

What is your annual income range?

1. Less than $20,000
2. $20,001 - $40,000
3. $40,001 - $60,000
4. $60,001 - $80,000
5. $80,001 - $100,000
6. $100,001 and above

Debrief Statement Block

The survey you have participated in is attempting to study the connection between future self continuity and the magnitude of psychological benefits in exercise, with a focus on commute modes. The scales you have completed are designed to assess your symptomatology of depression, anxiety, and stress, and your engagement in future-self envisioning. Our hypothesis is that high future- self continuity contributes to enhancing the psychological benefits countering depression, anxiety, and stress obtained through active commuting.

The data you have provided is anonymous, and the completed project will be available as a Senior Thesis in hard copy through Bard College's Stevenson Library and digitally through Bard College's Digital Commons. If you have any questions about the experiment, participants' rights, or the methods used, please contact the undergraduate researcher

at mg8765@bard.edu, the Bard College IRB at irb@bard.edu, or the faculty supervisor at lane@bard.edu.

Thank you for your participation!

Appendix B: Informed Consent Form

This document provides an overview of a research study conducted by a senior Psychology undergraduate at Bard College aimed at investigating the connections between active commuting habits and future self continuity. Bicycling and other active modes of transportation have been identified as physical activities that can yield positive mental health benefits in numerous ways. The primary objective of this study is to explore the role of future self continuity in enhancing these positive effects, particularly in terms of perceived stress, anxiety, and depression.

As a participant, you will be asked to complete a questionnaire designed to collect pertinent data. The questionnaire should take no more than fifteen minutes to complete. This will involve responding to personal queries concerning your mental health characteristics, general wellbeing, symptoms related to depression and anxiety, and experiences of stress. We caution that these questions may evoke strong emotions or recall of distressing memories, as they require introspective reflection on your mental state. We understand that the topics covered in this questionnaire can be sensitive, and we prioritize your comfort and well-being throughout this study. Therefore, if at any point you encounter a question that you find too uncomfortable or distressing to answer, we want to emphasize that you have the complete freedom to skip that question.

We encourage you to prioritize your mental and emotional well-being at all times while participating in this study. We ask, however, that the survey be completed to the best of your ability. Please note that your participation in this study is entirely voluntary. You may choose not to participate without any repercussions, and there will be no penalty or loss of benefits to which

you are entitled. Moreover, you have the right to withdraw from the study at any point in time without any negative consequences. Upon completing the study, you will be compensated for your time.

We want to assure you that your privacy is of utmost importance to us. All responses will be collected and analyzed anonymously, and no identifying information will be saved to the dataset. Your individual responses will be anonymous at every stage of the study. Data may be archived and publicly accessible at online repositories such as the Open Science Framework. No identifying information will be included in such a posting. Due to the risk involved with this study, a resource for addressing mental health concerns is offered below and at the end of the study. We encourage that you access this resource in the case of crisis onset by participation in this study or otherwise.

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If you have any questions regarding the nature of the study or participants' rights, please contact the undergraduate researcher at mg8765@bard.edu, the Bard College IRB at irb@bard.edu, or the faculty supervisor at lane@bard.edu.

1. I am at least 18 years of age and I understand the procedure and risks associated with the current study and provide my informed consent to proceed.

Appendix C: Debrief Statement

The survey you have participated in is attempting to study the connection between future self continuity and the magnitude of psychological benefits in exercise, with a focus on commute modes. The scales you have completed are designed to assess your symptomatology of depression, anxiety, and stress, and your engagement in future-self envisioning. Our hypothesis is that high future- self continuity contributes to enhancing the psychological benefits countering depression, anxiety, and stress obtained through active commuting.

The data you have provided is anonymous, and the completed project will be available as a Senior Thesis in hard copy through Bard College's Stevenson Library and digitally through Bard College's Digital Commons. If you have any questions about the experiment, participants' rights, or the methods used, please contact the undergraduate researcher at mg8765@bard.edu, the Bard College IRB at irb@bard.edu, or the faculty supervisor at lane@bard.edu.

Thank you for your participation!

Appendix D: Budget Statement

$230 for Prolific recruitment of 115 participants, at $2 compensation per participant upon completion, with a service fee of $76.67, totalling $306.67.