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Assessing Bicycle Helmet Use in College-aged Individuals Using the Transtheoretical Model of Behavior Change

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Traumatic brain injury is a serious public health problem in the United States, and cycling represents the largest category of sports-related head injuries. Helmets can significantly lower the risk of brain injury for cyclists of all ages. Yet, the incidence of traumatic brain injury as a result of a bicycle-related injury remains high. Due to consistently low base rates of helmet use in the college-aged population, this group is a prime target for research and interventions focused on bicycle helmet use behaviors. This research uses Prochaska and DiClemente's Transtheoretical Model (TTM) of behavior change to examine bicycle helmet use behaviors in college-aged individuals. This study builds upon previous research to address all four constructs of the TTM (Stages of Change, Decisional Balance [Pros and Cons], Self-Efficacy [Confidence and Temptation], and Processes of Change [Experiential and Behavioral]). Questionnaires were administered to undergraduate psychology students in Spring semester 2015 and Fall semester 2016 at two universities in the northwestern United States (N=547). Chi-square tests for independence were conducted to analyze the relationship between bicycle helmet use and demographic characteristics, bicycle-riding behaviors, and past experiences. Three ANOVAs (with Tukey's post-hoc analyses) and 3 Welch ANOVAs (with Games-Howell post-hoc analyses) were used to analyze the application of the constructs of the TTM to helmet use, and to permit comparison to the theoretical relationships predicted by the TTM model. Overall, the relationships among the constructs of the TTM were similar to those found when the TTM is applied to other health-related behaviors. The largest portion of variance among the 5 stages was derived from Processes of Change construct, followed by the Self-Efficacy construct, and then the Decisional Balance construct. Behavioral and Experiential Processes accounted for the largest magnitude of difference between the Precontemplation and Contemplation stages; Confidence and Behavioral Processes accounted for the largest magnitude of difference between the Preparation and Actions stages. These findings support future application of the TTM to conceptualize bicycle helmet use in college-aged individuals and to inform the development of helmet promotion interventions. Specific examples about how to modify helmet-related interventions based on the TTM are provided. This research contributes to the limited body of knowledge focused on the application of health behavior theories to understand bicycle helmet use.

Assessing Bicycle Helmet Use Behaviors in College-Aged Individuals Using the Transtheoretical Model of Behavior Change

Traumatic brain injury (TBI) is a serious public health problem in the United States (Langlois, Rutland-Brown, & Wald, 2006). TBI is among the leading cause of death and disability in individuals under the age of 45 years (Whelan-Goodinson, Ponsford, Johnston, & Grant, 2009). Individuals who experience a TBI are faced with long-term cognitive, neurological, psychiatric, social, and medical consequences (Rutherford & Corrigan, 2009). Strikingly, approximately 2% of the total population has a long-term need for daily assistance as a result of TBI (Thurman, Alverson, Dunn, Guerrero, & Sniezek, 1999). The estimated direct and indirect cost of TBI in the United States in the year 2000 was 60 billion dollars (Finkelstein, Corso, & Miller, 2006).

Cycling represents the largest category of sports-related head injuries (American Association of Neurological Surgeons [AANS], 2011). In 2013, there were 493, 884 nonfatal emergency department (ED) visits and 925 fatalities because of bicycle-related injuries (National Highway Traffic Safety Administration [NHTSA], 2015). While there was a one percent decrease in fatalities from all motor vehicle crashes (including cyclists) from 2010 to 2013, bicyclist deaths increased by 19 percent during this same time (Web-based Injury Statistics Query and Reporting System, 2015). Brain injuries occur in about 70 percent of all fatal bicycle crashes (NHTSA, 2008), and cycling contributed to an estimated 85,389 head injuries seen in EDs in 2009 (AANS, 2011).

Bicycle helmet use across all ages is important to prevent injury and death (Schulman, Sacks, & Provenzano, 2002). Research has shown that helmets can lower the risk of brain injury by up to 88 percent for cyclists of all age groups (Thompson, Rivara, & Thompson, 1999).

Indeed, Schulman and colleagues estimated that 327 fatalities, 6900 hospitalizations, and 100,000 ED visits due to bicycle-related brain injuries could have been prevented by universal use of helmets across the United States in 1997. These researchers also calculated more than $81 million direct health costs and $2.3 billion in indirect health costs related to these preventable bicycle-related brain injuries. Although these impressive findings highlight the importance of helmet use, the incidence of TBI as a result of bicycle-related injury remains high.

Using Research to Support Bicycle Injury Prevention Efforts

Despite an increased involvement by the health community in the 1980s when bicycle-related injuries began to be viewed as a public health problem (National Research Council, 1985), research has noted that only about 16 percent (Weiss, Okun, & Quay, 2004) to 20-25 percent (NHTSA, 2008) of riders wear bicycle helmets. Many prevention efforts aim to increase bicycle helmet use in youth, including school-based interventions, community programs and campaigns, physician advice, and legislative action (Quine, Rutter, & Arnold, 2001). Yet, minimal change in bicycle helmet use behaviors has occurred in the past decade.

Injury prevention and changing health-related behaviors is a difficult task, especially for risks that people view as unlikely to happen to them (Weinstein, 1980). Therefore, the information must be presented in a complex process that includes beliefs, the ability of the individual to change the behavior, and attitudes about the new behavior (Runyan & Runyan, 1991). Yet, in a review of the literature that combined injury causes, theories, and models, Trifiletti and colleagues found few examples of behavioral and social science theories being applied to understand the complex process of unintentional injury prevention (Trifiletti, Gielen, Sleet, & Hopkins, 2005). Undeniably, the application of behavioral science to injury prevention has lingered behind other approaches in the history of injury prevention efforts (Gielen& Sleet, 2003). Without a theory-driven approach, many of these interventions failed or attained limited success (Weiss, 1996).

Application of behavioral theories to injury prevention. The failure to utilize health behavior theories to understand behavioral health factors and to develop effective interventions may be a core factor behind the limited success of injury prevention efforts to change behaviors (Gielen& Sleet, 2003). Health behavior theories offer important insight into behavioral change, and these theories are most applicable at different levels of influence (Glanz & Rimer, 1995). Specifically, the intrapersonal level of influence focuses on the impact of an individual's knowledge, beliefs, and attitudes on behavior. Health behavior theories that emphasize cognition, motivation, and perception are most applicable at this level. The interpersonal level of influence focuses on how significant others (e.g., family, friends, and coworkers) impact behavior, and theories that emphasize social influence and norms are most applicable at this level. The community level of influence focuses on the impact of organizations, policies, and society. Theories that emphasize the involvement and change of organizations and communities are most applicable at this level (Glanz & Rimer, 1995).

When health behavioral theories were first utilized to enhance injury prevention efforts at the individual level (inclusive of both the intrapersonal and interpersonal levels) the emphasis on different theories was apparent (Gielen & Sleet, 2003). The theoretical models were both continuum and stage-based. In a continuum model, the theory predicts an individual's placement on an intention or behavior continuum based on the effect of perceptions or beliefs (Rutter & Quine, 2002). Thus, an intervention aims to alter perceptions and beliefs, and in turn move a person on that continuum of intention or behavior. In contrast, a theory may be stage-based, in which intentions or behaviors are viewed as discreet stages. Thus, an intervention aims to move an individual through the stages, with each stage representing different levels of intentions and behaviors toward the outcome of behavior change.

Continuum models such as the Theory of Reasoned Action (Fishbein & Ajzen, 1975) and the Health Belief Model (HBM; Rosenstock, 1974) are two theories that have been applied to injury prevention efforts. The Theory of Reasoned Action highlights a person's intention to perform a behavior, in which intention is a function of attitudes and subjective norms about engaging in the behavior (Fishbein & Ajzen, 1975). Attitude is the result of beliefs about the consequences of the behavior and the relative importance of these consequences. Subjective norms about engaging in the behavior result from beliefs about significant others' preferences and an individual's motivation to comply with the beliefs of others. For example, regarding bicycle helmet usage (Rutter & Quine, 2002, p.12), the belief regarding the consequence may be that 'Wearing a safety helmet would protect my head if I had an accident,' and the relative importance of this may be that 'Protecting my head if I had an accident is good/bad.' The perceived social norm may be that 'My parents think I should wear a safety helmet,' weighted by the motivation to comply with that belief (e.g., 'Generally I want to do what my parents think that I should do'). The Theory of Reasoned Action has been expanded into the Theory of Planned Behavior, in which behavior is viewed as a result of both intentions and perceived behavioral control (Ajzen, 1991). The Theory of Planned Behavior added the construct of perceived behavioral control to address situations in which volitional control is viewed as low, such as when environmental factors prevent or discourage a behavior despite the person's internal motivation.

The Health Belief Model (HBM; Rosenstock, 1974) suggests that people will change health behaviors in response to a perceived threat. The HBM states that the following three beliefs are motivators, and if activated, will increase the likelihood that an individual will engage in preventative health behavior: (1) he or she is susceptible to the threat or danger, (2) the consequences of the targeted danger are severe, and (3) he or she can take some action that will prevent the threat or danger, and the benefits of action will outweigh any barriers (Gross & Bonwich, 1982; "Health Belief Model," 2007; Rosenberg, Zirkle, & Neuwelt, 2005). For example, regarding bicycle helmet use, the perceived threat includes susceptibility to a cycling crash and estimated severity of the consequences (e.g., the possibility of a brain injury). The action that will prevent the threat or danger is helmet use, barriers may be perceived as inconvenience and peer pressure, and the benefit of action is improved safety (Lajunen & Räsänen, 2004).

The HBM provides a functional theoretical framework to investigate the cognitive aspects of health-related behaviors, yet criticisms of the HBM exist. For example, research has suggested that applying the HBM to change subjects' intentions to use a bicycle helmet is less effective than the Theory of Planned Behavior (Lajunen &Räsänen, 2004). Furthermore, Quine and colleagues found that the HBM has lower predictive utility than the Theory of Planned Behavior when applied to bicycle helmet use behaviors (Quine, Rutter, & Arnold, 1998). In a meta-analysis of the relationship between the components of the HBM (Susceptibility, Severity, Benefits, and Costs) and health behavior, Harrison, Mullen, and Green (1992) found that only 16 studies demonstrated criteria for measuring all components of the HBM and included reliability measures. Small to negligible effect sizes---ranging from .001 to .09---were calculated across these 16 studies. Taken together, this research suggests that the effect of HBM measures on behavior is not useful to explain and predict health-related behaviors.

In contrast to continuum models, a stage-based model suggests that behavior change occurs in a series of different steps. Stage-based models propose that obstacles people face during behavior change will differ at different stages. Therefore, intervention will be most effective when personalized to the current stage, and stage models seem to explain why 'one-size-fits-all' interventions are seldom effective (Lichtenstein & Glasgow, 1992). Prochaska and DiClemente's Transtheoretical Model (TTM) of behavioral change is a comprehensive stage-based model of behavior change that emerged during an empirical investigation of the processes a person uses to change his or her smoking behavior (Prochaska & DiClemente, 1983; Prochaska, DiClemente, & Norcross, 1992). This health behavior theory focuses on intentional behavioral change and individual decision-making. The TTM is the most commonly used stage model and is utilized to design interventions and individual treatments in many health-related fields (Littell & Girvin, 2002).

Application of Theory-Based Interventions to Promote Helmet Use. In the history of helmet promotion interventions in the United States, interventions tend to view helmet use as a 'common sense' practice (Quine, Rutter, & Arnold, 2002). Furthermore, current helmet promotion programs use a wide variety of strategies and differ greatly in effectiveness (Royal, Kendrick, & Coleman, 2007). These campaigns often simply provide educational materials, utilize presentations to large groups that emphasize helmet awareness and the dangers of not wearing a helmet, and provide discounted or free helmets. Most of the research and intervention in this area has focused on school-aged children.

One such program, the ThinkFirst program, is a brain and spinal cord injury prevention program that uses an established curriculum to teach people how to reduce their risk for injury. This program is based on the HBM and is promoted by the ThinkFirst Foundation (ThinkFirst

National Injury Prevention Foundation; www.thinkfirst.org). The ThinkFirst Foundation was established in 1985 by the American Association of Neurological Surgeons and the Congress of Neurological Surgeons to address the high prevalence of TBIs and spinal cord injuries.

Using the principles of the HBM, the ThinkFirst Program focuses on education, promotes safe environments and safety products, and endorses safety legislation (Rosenberg et al., 2005). Although the Think First National Injury Prevention Foundation has been commended for making advances in developing a multilevel approach to brain and spinal cord injury prevention (e.g., Rosenberg et al.), other research has not found promising results. In an appraisal of the ThinkFirst Program, Wright, Rivara, and Ferse (1995) found that the hour-long program, usually presented in an all-school assembly format, had essentially no impact on a participant's knowledge, self-reported behavior, or observed behavior. This study used before and after questionnaires and direct observation to measure seatbelt and helmet use in three junior high and three senior high schools in the state of Washington. The authors reported a small impact on knowledge about brain and spinal cord injury safety, but found no influence of attitude change, self-reported behavioral change, or observable behavioral change toward brain and spinal cord injury and prevention approaches (e.g. wear a helmet).

In an investigation into the effectiveness of another school-based helmet promotion program, Pendergrast and colleagues conducted a school-level intervention at two elementary schools in the state of Georgia (Pendergrast, Ashworth, DuRant, & Litaker, 1992). An educational campaign occurred in both schools, during which children and parents were given bicycle helmet safety literature and coupons for discounted helmets. In one school, the educational campaign was enhanced by an intensive safety intervention that included safety meetings and classroom presentations. Ten months after the intervention, reported helmet ownership increased at both schools, but only a slight increase in actual helmet use was reported at the school that received the intensive intervention (from 6.8% to 9.3% of participants). The only significant finding between the two schools was that children who received the intensive intervention were more likely to believe that helmets were protective.

During this same period, Towner and Marvel (1992) implemented a school-based intervention at six elementary schools in the state of Wisconsin. This intervention was a 5-day long campaign that used prizes, discount vouchers, and a ‘fear appeal’ approach in which an egg (representing the skull) was dropped with and without the protection of an egg carton (the helmet). Self-reported helmet ownership increased across schools after this intervention (from 13% to 27%), yet there was no increase in observed helmet use.

Ludwig, Buchholz, and Clarke (2005) investigated the effect of a social marketing intervention on bicycle helmet use at a university in the southeastern United States. This intervention was based on social marketing approaches that use a desirable format for the target audience, promote the target behavior as familiar and desirable, facilitate communication among those promoting behavior change and the target audience, and minimize barriers to engaging in the desired behavior. Thus, this intervention included college-peers who actively promoted helmet use by encouraging others to sign pledge cards, the distribution of educational materials with a focus-group designed slogan, and access to free helmets. Using systematic field observations, this research reported a mean helmet use of 26.1 percent during the baseline period, which increased throughout the 5-week intervention period to a mean of 49.3 percent, then decreased to a mean of 44.4 percent after the intervention ended. These researchers reported follow-up observational data for 32 weeks (38.6% of riders wore a bicycle helmet), 45 weeks (52% of riders wore a bicycle helmet), and 58 weeks (33.2% of riders wore a bicycle helmet).

This statistically significant increase in bicycle helmet use over the course of this study, and the fact that helmet use remained above baseline after the 5-week intervention, should be applauded. This research highlights the complex components and long-term impact of a successful helmet intervention. Indeed, these authors recommended that helmet interventions should occur continually on college campuses to maximize effectiveness.

In a systematic review of the literature on the effectiveness of non-legislative interventions to increase bicycle helmet use among children, Royal, Kendrick, and Coleman (2005) reviewed 22 studies that focused on helmet promotion campaigns targeted to individuals ages 0 to 18. The campaign methods described in these studies varied, including health education programs, programs that allocated free or reduced helmets, media campaigns, and programs that utilized a mixture of these methods. Outcome measures included observed bicycle helmet usage, self-reported ownership of a bicycle helmet, and self-reported wearing of a bicycle helmet.

Royal et al. (2005) concluded that campaigns promoting bicycle helmet use by children usually work, while some work better than others. These authors noted that school-based helmet promotion interventions increase helmet usage, but perhaps less than community-based interventions and interventions that provide free helmets. Furthermore, these authors suggested that school-based interventions may be most effective for younger children. Noted limitations included the wide variety of methods utilized, variable outcome measures reported, and the short follow-up period to assess helmet usage (ranging from 2 weeks to 1 year). No such systematic review has been done for non-legislative helmet promotion campaigns that target individuals older than 18 years.

Bicycle Helmet Use in College-Aged Individuals

Despite the risk of death and injury due to TBI associated with bicycle riding without a helmet at *all* ages (Schulman et al., 2002), research has consistently demonstrated that the majority of college-aged individuals do not wear a helmet. For example, Weiss (1996) reported observed rates of bicycle helmet usage over a decade at the University of Arizona. This research reported that 15 cyclists (10% of the observed sample) wore a helmet in 1985, ten cyclists (4.4% of the observed sample) wore a helmet in 1990, and 40 cyclists (24% of the observed sample) wore a helmet in 1994. Fullerton and Becker (1991) assessed bicycle helmet use at the University of New Mexico. Thirty-one percent of participants who rode a bicycle owned a helmet. Seventeen (54.8%) of those who owned a helmet wore a helmet more than three-fourths of the time.

Other studies also highlight the low rate of helmet use on college campuses in the 1990s. Page and colleagues investigated bicycle helmet use at a state university in the Pacific Northwest (Page, Follett, Scanlan, Hammermeister, & Friessen, 1996). Only 42.5% of the participants who owned a bike reported owning a bicycle helmet, and those who owned a helmet reported wearing it an average of 18.1% of the time they rode. Coron, LcLaughlin, and Dorman (1996) surveyed students at the University of Florida regarding bicycle helmet attitudes and behaviors. Of the 272 bicyclists sampled, 50 (18.4%) indicated that they wore a helmet. Also in 1996, Everett and colleagues found that only 49 (20%) the students sampled at three universities in the Midwest classified themselves as helmet wearers (Everett, Price, Bergin, & Groves). In a report on health risk behaviors among college students in California, only five percent of student bicyclists always wore a helmet (Patrick, Covin, Fulop, Calfas, & Lovato, 1997). The majority (80.1%) of bicyclists who did not always wear a helmet (95.0% of the student bicyclists sampled) reported that they never wore a helmet during the past year.

A low rate of bicycle helmet usage on college campuses continues into the 21st century. As noted previously, Ludwig et al. (2005) investigated the effect of a social marketing intervention on bicycle helmet use at a university in the southeastern United States. Using systematic field observations, these researchers indicated a mean helmet use of 26.1 percent during the baseline period. Kakefuda (2008) reported that 37% of respondents at Colorado State University wore a bicycle helmet every time they rode recreationally, and only 9% of respondents indicated that they wore a bicycle helmet while commuting. Ross and colleagues (2010) indicated that 46 percent of students sampled at a public college in the Southeast owned a bicycle helmet; yet, only 12 percent of respondents reported that they wore a helmet, and 72 percent reported not wearing a helmet with no future intention of wearing one (Ross, Ross, Rahman, & Cataldo). Hammond and Hall (2015) investigated bicycle helmet use among undergraduate students at the University of Montana. Only 23.1 percent of participants indicated that they consistently wore a bicycle helmet, while 50.4 percent of the respondents reported no helmet use and no intention to wear one in the next six months.

Bicycle helmet use by college-aged individuals is an important issue. The statistics from college campuses around the United States show remarkably low base rates of helmet use. Therefore, this population is a prime target for research and interventions focused on bicycle helmet use behaviors.

Using the TTM to Increase Bicycle Helmet Use Behaviors

Despite the history and current use of interventions, bicycle-related TBI continue at a high rate (AANS, 2011), suggesting that a different approach to brain injury prevention and helmet promotion is necessary. Indeed, as noted in the literature, "translating health behavior theories and models into action programs is essential for injury prevention" (Gielen & Sleet, 2003, p. 71). As previously mentioned, one such approach with strong empirical support is Prochaska and DiClemente's Transtheoretical Model (TTM) of behavior change (Prochaska & DiClemente, 1983).

In the only published study to apply the TTM to bicycle helmet use, Weiss, Okun, and Quay (2004) sought to understand how predictor variables (Gender, Knowledge About Bicycle Safety, and Pros and Cons Score of Helmet Use) interact to categorize a sample of seventh graders, ninth graders, and college students by stage of change (SOC). The stages included Precontemplation, Contemplation, Preparation/Action (collapsed due to the low number of participants in these stages), and Maintenance. These authors found that the TTM differentiated cyclists into the appropriate stages of change, and suggested that the TTM is a useful conceptual framework for understanding bicycle helmet usage. Thus, these authors recommended that an intervention to promote helmet usage should consider an individual's current SOC. In a separate application of the TTM to bicycle helmet use, Hammond and Hall (2015) explored the relationship between SOC and another construct of the TTM, the Decisional Balance construct. This research supported the application of the TTM to understand bicycle helmet use behaviors, and these authors also recommended that the TTM be utilized to enhance helmet promotion interventions.

Although this research was an informative start, more comprehensive research is necessary to better understand the application of Prochaska and DiClemente's TTM of behavior change to bicycle helmet use. As such, it is important to address the application of all four constructs of the TTM to bicycle helmet use. This includes the Stages of Change construct, the

Decisional Balance construct, the Self-efficacy construct, and the Processes of Change construct. Figure 1 summarizes the four constructs of the TTM.

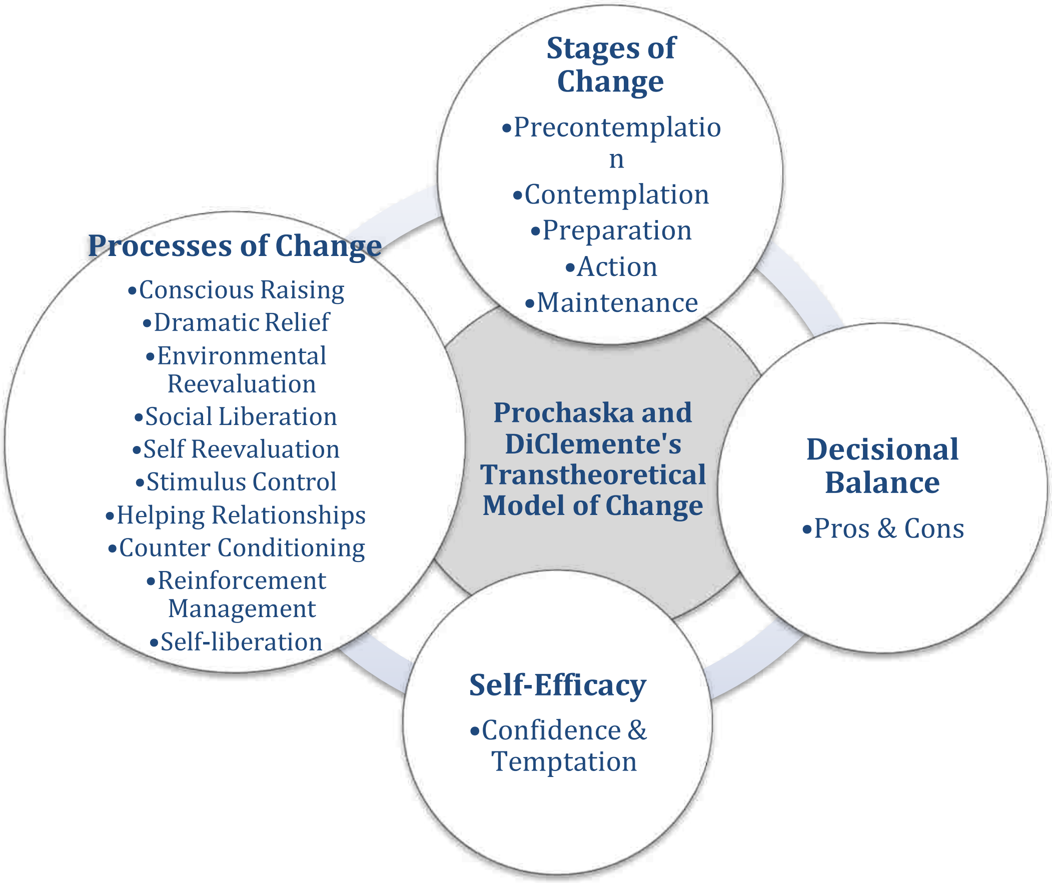


Figure 1. The four constructs of Prochaska and DiClemente's Transtheoretical Model of behavior change.

Stages of Change Construct. The Stages of Change construct includes discrete stages of change to help explain when specific changes in attitudes, intention, and behaviors occur (Prochaska et al., 1992; Prochaska & Marcus, 1994). Prochaska and DiClemente's TTM model identifies the following five stages of change: Precontemplation, Contemplation, Preparation, Action, and Maintenance (Prochaska et al., 1992; Table 1).

Table 1

SOC Classification Based on Response to the SOC Measure

Stage of Change	Response
Precontemplation	No, and I do NOT intend to in the next 6 months
Contemplation	No, but I intend to in the next 6 months
Preparation	No, but I intend to in the next 30 days
Action	Yes, I have been for LESS than 6 months
Maintenance	Yes, I have been for MORE than 6 months.

The stages of change characterize a time period and the tasks necessary to progress to the next stage (Norcross, Krebs, & Prochaska, 2011). In the Precontemplation SOC, the individual has no intention to change behavior in the near future. Individuals in this stage are usually unaware (or not aware enough) of their problems, and resistance to recognizing or changing a problem behavior is very common. In the Contemplation SOC, the individual is aware of the problem and considering change, but no commitment to action has been made. Individuals in this stage struggle with the positive and negative evaluations of their problematic behavior (e.g., what it will cost to overcome the behavior), and ambivalence towards change may result from this weighing of the costs and benefits (Velicer, Prochaska, Fava, Norman, & Redding, 1998). In the Preparation SOC, the individual intends to take action within the next month but has not reached criterion for the Action stage. Individuals in this stage usually make attempted approximations of the desired behavior change. In the Action SOC, individuals modify their behaviors, experiences, or environment to successfully alter the behavior for one day to six months. This stage is characterized by the most explicit behavioral change. The Maintenance SOC is a continuation of the Action stage that focuses on stabilizing behavior change and preventing relapse. Individuals in this stage have avoided the problem behavior and/or engaged in the new behavior for six months or more. Regression can occur at any stage when an individual moves to an earlier stage (Velicer et al., 1998).

Research has described how messages about a target behavior should be modified based on an individual's current SOC, and how these messages can be designed to facilitate movement across stages (e.g., Maibach & Cotton, 1995). In the progression from the Precontemplation stage to the Contemplation stage, the message should encourage active behavior reevaluation and preliminary consideration of the new behavior. An important aspect of the Contemplation stage is evaluating the Pros and Cons of the problem behavior and the solution (Prochaska et al., 1992). Therefore, in the progression from the Contemplation stage to the Preparation stage, the message should encourage weighing the costs and benefits of the problem behavior and trying the new behavior at least once, a term referred to as gaining "behavioral experience" (Maibach & Cotton, p. 56). In the progression from the Preparation stage to the Action stage, the message should encourage maintaining motivation and self-efficacy, restructuring the individual's social environment, and planning for obstacles. In the progression from the Action stage to the Maintenance stage, the message should encourage building self-management, skill-refinement, and self-efficacy to deal with possible relapses.

Decisional Balance Construct. The Decisional Balance construct focuses on the importance placed on the Pros and Cons of behavior change (Velicer et al., 1998). An important association has been demonstrated between an individual's SOC and the Decisional Balance construct. In an examination of the relationship between the stages of change and the Pros and the Cons of 12 problem behaviors, Prochaska et al. (1994) demonstrated that the Pros become more important and the Cons become less important as an individual moves towards a behavior change. Based on these findings, Prochaska et al. suggested that individuals will decide that the

Pros of changing the behavior are more important than the Cons of changing the behavior before taking action for most problem behaviors.

Additionally, the type of behavior change may impact how the Pros and Cons are evaluated in the Action and Maintenance stages. During the cessation of a problem behavior (e.g., quitting smoking), the Pros of a problem behavior tend to decrease from the Action SOC to the Maintenance SOC. During the acquisition of a healthy behavior (e.g., engaging in regular physical activity), the Pros tend to remain high during these stages. This difference likely highlights the ongoing decisions that are necessary to maintain a healthy behavior (Velicer et al., 1998).

Previous research has examined the relationship between bicycle helmet use behaviors and the Stage of Change and Decisional Balance constructs in college-aged individuals (Hammond & Hall, 2015). After placing participants into a SOC based on their current helmet use behaviors, these authors examined the importance placed on the Pros of helmet use (e.g., helmets decrease head injuries; I feel safer when I wear a helmet while riding a bike) and Cons of helmet use (e.g., wearing a helmet is uncomfortable; wearing a helmet will mess up my hair) at each SOC. This research found that the importance placed on the Pros and Cons of helmet use was similar to previous research that supports the use of the TTM to conceptualize and address health-related behavior change, (e.g., Prat, Planes, Gras, & Sullman, 2012; Prochaska et al., 1994; Velicer et al., 1998). There was a simultaneous decrease in the Cons and increase in the Pros from the Precontemplation SOC to the Contemplation SOC, suggesting a distinct change in the importance placed on the Pros and Cons of helmet use as one becomes more solidified regarding his or her decision to change his or her helmet use behaviors. As such, these authors recommended that interventions targeted at individuals in the Precontemplation SOC should emphasize the Pros of wearing a helmet (e.g., protection from cars) and decrease the Cons of wearing a helmet (e.g., a helmet is uncomfortable).

Hammond and Hall (2015) also found that a crossover between the Pros and Cons of bicycle helmet use occurred during the Preparation SOC. This supported the assertion in the literature that, for most problem behaviors, people will decide that the Pros of changing are more important than the Cons before altering their behavior (Prochaska et al., 1994). A large discrepancy between the Pros and Cons was apparent in the Maintenance SOC. These findings were in agreement with previous research (Velicer et al., 1998) that suggests that the Pros remain high for the addition of healthy behavior. Therefore, interventions designed to target individuals in these later stages of change should encourage maintaining motivation (e.g., continued weighing of the costs and benefits of helmet use) and planning for obstacles (e.g., keeping the helmet in a convenient location).

Self-Efficacy Construct. Adapted from Bandura's self-efficacy theory, the Self-efficacy construct focuses on the confidence individuals have in their coping abilities and avoiding relapse (Velicer et al., 1998). The Self-efficacy construct addresses an individual's confidence during a specific situation, particularly during difficult situations that do not support the behavior change. Confidence in one's ability to perform is related to actual performance, and self-efficacy impacts motivation and persistence (Bandura, 1977). Previous research has demonstrated that one's belief in his or her self-efficacy predicts future behavior better than previous behavior (DiClemente, 1981). Research has also demonstrated a positive relationship between self-efficacy and behavior change in a variety of domains, including exercise behavior change (e.g., Marcus, Selby, Niaura, & Rossi, 1992), smoking cessation (e.g., DiClemente, Prochaska, &

Gibertini, 1985), weight-loss (Bernier & Avard, 1986), and emotional readiness for adoption (Prochaska et al., 2005)

The Self-efficacy construct of the TTM includes two related components: self-efficacy (Confidence) and Temptation (Velicer et al., 1990). The self-efficacy component reflects the confidence an individual has to make and maintain a behavior change, and the temptation component reflects the pull to regress to an earlier SOC. Research has demonstrated that self-efficacy is particularly important during the later stages of change, and measures of self-efficacy predict relapse (Velicer et al., 1998). As such, individuals report greater confidence and less temptation as they progress through the stages of change (Prochaska et al., 2005).

Processes of Change Construct. The Processes of Change construct includes cognitive and behavioral processes that help explain how the shift between stages of change occurs (Prochaska et al., 1992). Individuals engage in these processes as they modify their behavior, and these processes may be overt or covert (Norcross et al., 2011). Ten Processes of Change, including five Experiential processes and five Behavioral processes, have received considerable support in the literature (Prochaska & DiClemente, 1983; Prochaska, Velicer, DiClemente, & Fava, 1988).

The Experiential Processes of Change include Conscious Raising, Dramatic Relief, Environmental Reevaluation, Social Liberation, and Self Reevaluation (Velicer et al., 1998; Table 2). Conscious Rising involves increasing awareness about the consequences and cures for the problem behavior. Feedback, education, and media campaigns are interventions that increase awareness. Dramatic Relief involves emotional arousal regarding the problem behavior. Role-playing, personal testimonies, and media campaigns are interventions that may impact progression through stages by inducing emotional arousal. Environmental Reevaluation involves social reappraisal of the effect of the individual's behavior on others. Empathy training, documentaries, and family involvement are interventions that may support individuals in this reappraisal process. Social Liberation involves an increase in social opportunities that support the behavior change, such as smoke-free zones and health promotion for minorities. Interventions that focus on advocacy and policies to support these opportunities impact processes in this domain. Self Reevaluation involves how an individual views his or her self-image with and without the problem behavior. Interventions that focus on value clarification, imagery, and role models may support stage progression through self-evaluation. Overall, Experiential Processes are more commonly used in progression through the earlier stages of change (Velicer et al., 1998).

The Behavioral Processes of Change include Stimulus Control, Helping Relationships, Counter Conditioning, Reinforcement Management, and Self Liberation (Velicer et al., 1998; Table 2). Stimulus Control involves the elimination of cues for unhealthy behaviors and the addition of cues for healthy behaviors. Interventions that address avoidance, self-help groups, and environmental rearrangement enhance an individual's stimulus control. Helping Relationships involves caring for the individual and support for the behavior change. Rapport building, buddy systems, and counselor calls are example of interventions that provide this support. Counter Conditioning involves learning healthy behaviors to substitute for problem behaviors. Interventions that promote relaxation techniques and skills to resist peer pressure support processes in this domain. Reinforcement Management involves consequences for behavior change, with an emphasis on reinforcements. Contingency contracts, group recognition, and overt reinforcements are interventions that support stage progression by managing reinforcements. Self Liberation involves belief in one's ability to change and commitment to act based upon that belief. Interventions that involve public testimonies and multiple choices for action (e.g., using a nicotine replacement, quitting cold turkey, or fading the use of nicotine are three choices that can be used to support smoking cessation) are important to support Self Liberation. Overall, Behavioral Processes are more commonly used in the later stages of change (Velicer et al., 1998).

Table 2

Processes of Change

	Process of Change	Cognitive and Behavioral Processes Involved
Experiential Processes	Conscious Raising	increase in awareness about the consequences and cures for the problem behavior
	Dramatic Relief	emotional arousal regarding the problem behavior
	Environmental Reevaluation	social reappraisal of the effect of the individual's behavior on others
	Social Liberation	increase in social opportunities that support the behavior change
	Self Reevaluation	view of self-image with and without the problem behavior.
Behavioral Processes	Stimulus Control	elimination of cues for unhealthy behaviors and the addition of cues for healthy behaviors
	Helping Relationships	caring for the individual and support for the behavior change
	Counter Conditioning	learning healthy behaviors to substitute for problem behaviors
	Reinforcement Management	consequences for behavior change, with an emphasis on reinforcements
	Self Liberation	belief in one's ability to change and commitment to act based upon that belief

The Processes of Change are the independent variables that must be applied to progress through the stages. Thus, the Processes of Change provide a valuable guide for interventions (Velicer et al., 1998). Indeed, research has found that the single best predictor of treatment outcome for weight control was the Processes of Change used early in treatment (Prochaska, Norcross, Fowler, Follick, & Abrams, 1992).

Critiques of the Transtheoretical Model of behavior change. Although Prochaska and DiClemente's Transtheoretical Model of behavior change is one of the most commonly embraced theoretical frameworks for encouraging and supporting individuals with lifestyle changes, critiques of the TTM exist. In a review of 37 randomized control trials targeting seven health behaviors, Bridle et al. (2005) evaluated the methodological quality of TTM interventions used to facilitate health-related behavioral changes. This review concluded that many common methodological limitations exist in this area of research, especially randomization, blinding, and data analysis. In a systematic review of 24 different TTM-based physical activity interventions performed from 1996-2005, only seven used all four dimensions of the TTM (Stages of Change, Decisional Balance, Self-efficacy, and Processes of Change) to develop the intervention (Hutchison, Breckon, & Johnston, 2009). As suggested by Bridle et al. (2005), numerous interventions based on the TTM may be faulty because all dimensions of the TTM should be used together to explain behavior change. Thus, a more complete intervention that does not minimize TTM to only the SOC construct is recommended.

It is also recommended that researchers be aware of the reliability of measures used to segment individuals according to SOC. Important differences between persons classified into different stages of change may be missed if the SOC measure is not reliable (Donovan, Jones, Holman, & Corti, 1998). Yet, reliability is difficult to assess in this situation because a 1-item measure does not permit the calculation of internal consistency, and a test-retest reliability measurement is difficult because the TTM suggests that individuals move between stages during short time frames. The minimal research that has investigated the reliability of SOC measures has reported moderate to high reliability. In research focused on exercise behavior, Marcus et al. (1992) reported a kappa coefficient (κ) of 0.78 using a test-retest method over a 2-week period.

In research focused on smoking cessation, reducing alcohol consumption, and exercise behaviors, Donovan et al. (1998) utilized a test-retest procedure in the same questionnaire (an open-ended SOC placement question was placed in the beginning of a questionnaire, and then participants were asked later in the questionnaire to classify themselves regarding a variety of behaviors [including smoking, drinking, and exercise] using SOC categories). These researchers reported a kappa coefficient of 0.72 for smoking behavior, 0.73 for alcohol usage behavior, and 0.52 for exercise behaviors. Hammond and Hall (2015) used a similar 2-part questionnaire to assess the reliability of a SOC placement question for bicycle-helmet use. In the first part of the questionnaire, the participant was asked the following question: "What would you say is the single most important thing you personally could do to improve your safety while riding a bicycle?" For the response topic, the respondent was asked to choose the statement that best applied to his or her current situation: *I currently [insert identified behavior] when I ride a bike; I have been [insert identified behavior] for LESS than 6 months; I intend to [insert identified behavior] in the next 30 days; I intend to [insert identified behavior] in the next 6 months; I do NOT intend to [insert identified behavior] in the next 6 months.*

Using the same answer choices, a 10-item measure was printed as a second part of the questionnaire to assess the reliability of the participant's response to the previous question. This second part of the questionnaire asked the participant to choose the best response statement regarding a variety of health-related behaviors, including quitting smoking, exercising, bicycle helmet usage, avoiding high fat foods, eating more fruits and vegetables, wearing a seatbelt in a car, wearing bright clothing/reflective tape, and biking at a safe speed. Using this approach, Hammond and Hall (2015) reported a Cohen's kappa coefficients of 0.78.

A focus on behavioral validation is also recommended when using measures that rely on self-report for SOC placement (e.g., Hellsten et al., 2008). Hellsten and colleagues reviewed nine studies that used a common physical activity SOC questionnaire. Overall, these authors found that self-report exercise and physical activity indicators differentiated between the Preparation and Action stages and between the Action and Maintenance stages, providing behavioral validity support for the physical activity SOC questionnaire. To assess the validity of the SOC placement instrument used to conceptualize bicycle helmet use behaviors in college-aged individuals, Hammond and Hall (2015) focused on participants who placed themselves in the Preparation SOC. These researchers reported that a statistically significant number of participants who placed themselves in the Preparation SOC wore a helmet within 30 days of initial classification. These findings provide initial validation for the one-item self-report measure used in this study.

Application of all constructs of the TTM. While research into the application of the TTM for health behavior change has often failed to include all aspects of the TTM (Bridle et al., 2005; Hutchison et al., 2009), some researchers have utilized all constructs of the TTM to conceptualize behaviors. For example, Nigg and Courney (1998) used the TTM framework to examine adolescent exercise behavior. Participants (N=819) completed a survey that included a SOC, Processes of Change, Self-Efficacy, and a Decisional Balance questionnaire. Overall, this research supported the application of the TTM to adolescent exercise behaviors.

These researchers found that the importance of the different constructs varied at different stages, and suggested that adolescents use the Processes of Change similar to adult participants. Specifically, this research demonstrated that the use of the Experiential Processes of Change increased from the Precontemplation to Contemplation SOC, and remained stable from the Contemplation to Preparation SOC. Furthermore, the use of the Experiential Processes of Change increased from the Preparation to Action SOC, and decreased from the Action to Maintenance SOC. The use of Behavioral Processes of Change increased from the Precontemplation SOC to the Action SOC, and leveled off at the Maintenance SOC.

Nigg and Courney (1998) also found that self-efficacy increased as participants progressed through the stages of change. Furthermore, regarding the Decisional Balance construct, the Pros increased from the Precontemplation to Maintenance SOC, and the Cons decreased from the Contemplation and Preparation SOC to the Maintenance SOC. Thus, these authors suggested that application of the Self-Efficacy and Decisional Balance constructs to adolescent exercise behavior was consistent with previous research in these domains.

Prochaska and colleagues (2005) applied the TTM to assess emotional readiness for adoption. These researchers developed measures for all four constructs of the TTM as applied to behaviors and attitudes associated with emotional preparation for adoption, then administered this assessment to 217 prospective adoptive parents. These researchers found significant differences in the Processes of Change utilized by individuals in four different stages (the Precontemplation SOC was not analyzed due to low numbers) of emotional readiness to be an adoptive parent. As the SOC increased, so did the use of both the Experiential and Behavioral Processes of Change. Furthermore, Prochaska et al. (2005) reported that self-efficacy was significantly different across stages of change, with individuals in the Contemplation SOC indicating significantly less confidence in his or her ability to take the steps to be emotionally prepared to be an adoptive parent. With regard to the Decisional Balance construct, the importance place on the Pros of adoption were significantly higher at the Action SOC and Maintenance SOC compared to the Preparation SOC, and the Cons were lower in the Maintenance SOC compared to the Contemplation SOC and Action SOC. Overall, this research supported the application of the TTM to conceptualize and assess emotional readiness to be an adoptive parent, and suggested that stage-based interventions may support professionals working with parents interested in adoption.

Research has also suggested that the TTM may be useful in other areas of behavior, including adherence to voice therapy (van Leer, Hapner, & Connor, 2008) and the bereavement process (Calderwood, 2011). While this literature varies in research approach and empirical evaluation, these authors make interesting suggestions about how application of all of the TTM constructs may be useful for an array of human behaviors. For example, Calderwood (2011) suggested that each SOC parallels different transformations of self that occur during the bereavement process. Furthermore, this author suggests that addressing specific Processes of Change during counseling based on current SOC may support an individual as he or she moves through the bereavement process.

Proposed Research

This research used the TTM of behavior change to examine bicycle helmet use behaviors in college-aged individuals. To build and expand upon earlier work that applied the TTM to bicycle helmet use behaviors (Hammond & Hall, 2015; Weiss et al., 2004), this study addressed criticisms that TTM interventions should consider all constructs of the model (Adams & White, 2005; Bridle et al., 2005).

Conceptually, this study had three general hypotheses relating to the application of the TTM to helmet use behavior. First, participants in SOC groups would differ with respect to their reported values placed on the Pros and Cons of helmet use. Second, participants in SOC groups would differ with respect to their reported levels of Confidence to wear a helmet and Temptation to not wear a helmet. Third, participants in SOC groups would differ with respect their reported use of Experiential and Behavioral processes.

Based on these general hypotheses, specific hypotheses for this research were developed in accordance with the theoretical relationships proposed in the literature regarding the application of the TTM to behavior change.

Hypotheses related to the Decisional Balance construct.

1. Participants in the Preparation SOC will rate the PRO of bicycle helmet use as significantly more important than participants in the Precontemplation and Contemplation stages of change
2. Participants in the Action SOC will rate the PRO of bicycle helmet use as significantly more important than participants in Precontemplation, Contemplation, and Preparation stages of change.
3. There will not be a significant difference in the importance placed on the PRO of helmet use by participants in the Action and Maintenance stages of change.
4. Participants in the Precontemplation SOC will rate the CON of bicycle helmet use as significantly more important than participants in the Contemplation, Preparation, Action, and Maintenance stages of change.

5. Participants in the Contemplation SOC will rate the CON of bicycle helmet use as significantly more important than participants in the Preparation, Action, and Maintenance stages of change.

Hypotheses related to the Self-Efficacy construct.

6. Participants in the Action SOC will report significantly greater levels of CONFIDENCE than participants in the Precontemplation, Contemplation, and Preparation stages of change.
7. Participants in the Maintenance SOC of change will report significantly greater levels of CONFIDENCE than participants in the Precontemplation, Contemplation, Preparation, and Action stages of change.
8. Participants in the Precontemplation SOC will report significantly greater levels of TEMPTATION than participants in the Contemplation, Preparation, Action, and Maintenance stages of change.
9. Participants in the Contemplation SOC will report significantly greater levels of TEMPTATION than participants in the Preparation, Action, and Maintenance stages of change.
10. Participants in the Preparation SOC will report significantly greater level of TEMPTATION than participants in the Action and Maintenance stages of change.

Hypotheses related to the Processes of Change construct.

11. Participants in the Precontemplation, Contemplation, and Preparation stages of change will report significantly greater use of the five Experiential Processes of Change than participants in the Action SOC.
12. Participants in the Action SOC will report significantly greater use of the Experiential Processes of Change than participants in the Maintenance SOC.

13. Participants in the Precontemplation, Contemplation, and Preparation stages of change will report significantly less use of the five Behavioral Processes of Change than participants in the Action SOC.
14. There will not be a significant difference in the reported use of the Behavioral Processes of Change by participants in the Action and Maintenance stages of change.

This research project contributes to the limited body of knowledge focused on the application of health behavior theories to understand bicycle helmet use. The findings support future application of the TTM to bicycle-related injury prevention and provide support for addressing helmet use in college-aged individuals. The risk of brain injury is high among this population, and they are a prime target for helmet-use research and intervention.

Methods

Participants

Participants were undergraduate students at two large universities in the northwestern United States. Participants were recruited in Spring semester 2015 and Fall semester 2016. Participants were required to be 18 years or older to be included in the research.

Procedure

Approval for all procedures was obtained from the UM Institutional Review Board (IRB), and compensation for participation was based on University policy. Per IRB policy between universities, data were collected at the second university under UM IRB approval and guidelines. Basic demographic information was collected (age, gender, ethnicity, total years of education completed). All participants completed a questionnaire about bicycle-riding behaviors and experiences (Appendix A) and bicycle helmet behaviors and attitudes (Appendices B through E). Participants at one site completed the questionnaire at a designated screening day, and students earned two experimental credit requirements for their psychology course for their participation. Participants at the other site completed the questionnaire at the end of a class period when the researcher visited the class with approval from the instructor; no research credits were offered for participation. Spring 2015 participants completed an informed consent form (Appendix F); identifying information was detached and stored separately from any data provided. At the time of Fall 2016 data collection, the UM IRB communicated that written informed consent was not necessary due to the project's exempt status. Thus, Fall 2016 participants received verbal consent and were not required to sign an informed consent form (no name or identifying information was collected). Participation was voluntary. Each participant completed all components of the questionnaire as described above.

Measures

The questionnaire included questions about bicycle-riding behaviors and experiences (frequency and distance of bike rides, reason and location for bike rides, and history of a bike accident that required medical treatment) and four different measures regarding helmet-use behaviors: A Stages of Change measure, a Decisional Balance measure, a Self-Efficacy measure, and a Processes of Change measure (Appendices A through F). Table 3 summarizes the measures included in the questionnaire.

Table 3

Summary of the Four Measures Included in the Questionnaire.

	Description
Measure 1: **Stages of Change**	1-item measure
	assess current SOC
Measure 2: **Decisional Balance**	10-item measure
	assess importance of the Pros and Cons of wearing a bicycle helmet
Measure 3: **Self-Efficacy**	30-item measure
	assess feelings of confidence to wear a helmet and temptation to not wear a helmet in different situations
Measure 4: **Processes of Change**	30-item measure
	assess use of cognitive, behavioral, and interpersonal strategies to proceed towards wearing a bicycle helmet

Measure 1: Stages of Change. A one-item measure was used to assess each participant's current SOC with regard to bicycle helmet usage (modified from DiClemente et al., 1991; see Appendix B). Participants chose the item that best described their current situation when asked the question "Do you wear a helmet when you ride a bicycle?" Response items included the following: *Yes, I have been for MORE than 6 months* [Maintenance stage]; *Yes, I have been for LESS than 6 months* [Action stage]; *No, but I intend to in the next 30 days* [Preparation stage]; *No, but I intend to in the next 6 months* [Contemplation stage]; or *No, and I do NOT intend to in the next 6 months* [Precontemplation stage]. Hammond and Hall (2015) reported adequate reliability of this measure, with a Cohen's kappa coefficient of0.78.

Measure 2: Decisional Balance. A ten-item measure was used to assess the importance of the Pros and Cons of wearing a bicycle helmet (modified from Weiss et al., 2004; see Appendix C). Participants indicated the relative importance on a five-point scale (1 = very unimportant to 5 = very important) of five Pro items and five Con items of wearing a bicycle helmet. Weiss et al. estimated valid internal consistency of these scales by coefficient alpha (.80 to .86 for the Pro scale and .61 to .80 for the Con scale) across a sample of 7th grade, 9th grade, and college students. Hammond and Hall (2015) reported good internal consistency of this measure, with a Cronbach's alpha of .80 for the Pro scale and .74 for the Con scale. In the current study, the Cronbach's alpha coefficient was .84 for the Pro scale and .71 for the Con scale.

Measure 3: Self-efficacy. A 30-itemmeasure was used to assess each participant's confidence to wear a helmet and temptation to not wear a helmet in a variety of situations (resulting in a 30-item Confidence measure and a 30-item Temptation measure). This measure was modified from self-efficacy scales regarding cocaine use, smoking, and exercise (www.uri.edu/research/cprc); see Appendix D). This part of the questionnaire included items that describe situations that lead some people to not wear a bicycle helmet. The participant was asked to indicate how confident he or she may be to wear a helmet (1 = not at all confident to 5 = extremely confident) and how tempted he or she may be to not wear a bicycle helmet (1 = not at all tempted to 5 = extremely tempted) in each situation. Prochaska, DiClemente, Velicer, Ginpil, and Norcross (1985) reported a coefficient alpha of .98 for smoking cessation self-efficacy assessment measures. Hammond and Hall (2015) reported good internal consistency for the Self-efficacy measure for bicycle helmet behaviors used in their research (a 10-item abbreviated version of the current measure that focused on temptation), with a Cronbach's alpha of .74. In the current study, the Cronbach's alpha coefficient was .98 for the 30-item confidence measure and .97 for the 30-item temptation measure.

Measure 4: Processes of Change. A 30-itemmeasure was used to assess how often cognitive, behavioral and interpersonal strategies are used to proceed towards wearing a bicycle helmet. This measure was modified from Processes of Change scales regarding cocaine use, smoking, and exercise (www.uri.edu/research/cprc; see Appendix E). This questionnaire measured the following Processes of Change: Consciousness Raising, Dramatic Relief, Environmental Reevaluation, Self Reevaluation, Social Liberation, Counter-conditioning, Helping Relationships, Self Liberation, Stimulus Control, and Reinforcement Management. The participant indicated the frequency on a 5-point scale (1 = never to 5 = repeatedly) for each question about strategies that he or she uses to proceed towards wearing a bicycle helmet. In a psychometric review of a Processes of Change scale for smoking cessation, Hoeppner et al. (2006) reported coefficient alphas ranging from .60 to .84, with most values in the low .70 to the low .80 range. Hammond and Hall (2015) reported good internal consistency for the Processes of Change measure for bicycle helmet behaviors used in their research (a 10-item abbreviated version of the current measure), with a Cronbach's alpha of .83. In the current study, the Cronbach's alpha coefficient for the 30-item Processes of Change measure was .96

Results

Statistical Analyses

Power analysis for a one-way ANOVA with 5 groups was conducted in G*Power (Faul et al., 2013) to determine a sufficient sample size (alpha of 0.05, a power of 0.80, and a medium effect size, f = 0.25); the desired sample size was 200 based on the aforementioned assumptions. Due to unequal distribution of participants into each level of the Independent Variable (IV), a larger sample size was collected. SPSS Statistics 22.0 was used for all analyses.

Chi-square tests for independence were conducted to analyze the relationship between bicycle helmet use and individual and behavioral factors. These variables included demographic characteristics (age, gender, and education) and bicycle-riding behaviors and experience variables (frequency and distance of bike rides, reason and location for bike rides, and history of a bike accident that required medical treatment). No a priori assumptions were made about the association between these variables and helmet use behaviors.

Standardized (T score) analyses were utilized to identify the use of TTM constructs related to bicycle helmet use, and to permit comparison to the theoretical relationships predicted by the TTM as applied to other health behaviors. Six one-way univariate analyses of variances (ANOVAs; Bonferroni corrected, $p < 0.0083$) were utilized to examine if participants in each SOC differ with respect to the TTM Constructs (Decisional Balance, Self-Efficacy, Processes of Change). The Welch's F test was used when the homogeneity of variance assumption was not met. Stage of Change was the Independent Variable (IV) and the TTM Constructs were the six Dependent Variables (DVs): Decisional Balance Construct [PRO/CON], Self-Efficacy Construct [CONFIDENCE/ TEMPTATION], and Processes of Change Construct [EXPERIENTIAL/ BEHAVIORAL]). Specifically, two ANOVAs were calculated to examine the effect of SOC on the importance placed on the PRO and CON of helmet use; this relates to hypotheses 1 through 5. Two ANOVAs were calculated to examine the effect of SOC on reported levels of CONFIDENCE and TEMPTATION; this relates to hypotheses 6 through 10. Additionally, two ANOVAs were calculated to examine the effect of SOC on use of the EXPERIENTIAL and BEHAVIORAL Processes of Change; this relates to hypotheses 11 through 14.

Tukey's and Games-Howell post-hoc analyses ($p < .05$) were used to further analyze significant differences, and effect sizes were calculated as eta squared ($\eta 2$) and omega squared (ω^2) to examine the magnitude of these differences. Effect sizes were categorized based on Cohen's (1988) guidelines in which a small effect accounts for one percent of the variance, a medium effect size accounts for six percent of the variance, and a large effect size accounts for 14 percent of the variance.

In addition, due to the innovative design and measures used in this study, supplementary analyses (item analyses and additional T score analyses) were conducted to further explore the application of each TTM construct to helmet use behaviors and interventions.

Internal Consistency of TTM Measures

Internal consistency was calculated for the novel measures developed for this project (Decisional Balance, Self-Efficacy, and Processes of Change). For the Decisional Balance Measure, the Cronbach's alpha coefficient was .84 for the Pro scale and .74 for the Con scale. For the Self-Efficacy Measure, the Cronbach's alpha coefficient was .98 for the 30-item Confidence measure and .97 for the 30-item Temptation measure. For the Processes of Change Measure, the Cronbach's alpha coefficient for the 30-item Processes of Change measure was .96.

Demographic Information

582 students completed the questionnaire. Thirty-five participants were excluded from the research (four questionnaires were completed by students younger than 18 years, 20 participants indicated that they had never ridden a bike, and 11 participants did not answer the SOC question). Thus, total valid participants were 547 undergraduate students, ranging in age from 18 to 56 years, with 10 to 19 years education. Characteristics of the study participants are summarized in Table 4.

Table 4

Demographic Characteristics of Study Sample

Gender (N=544)	
Males (*n*)	200 (36.8%)
Females (*n*)	343 (63.1%)
Age (N=542)	
M (SD)	21.65 (6.12)
Education (N=515)	
M (SD)	13.28 (1.63)
Race/Ethnicity (N=528)	
Caucasian (n)	441 (83.5%)
American Indian/Alaska Native (n)	14 (2.7%)
African origin (n)	6 (1.1%)
Latino (n)	25 (4.7%)
Asian American/Pacific Islander	11 (2.1%)
Biracial/Multiracial	24 (4.5%)
Other	7 (1.3%)

Bicycle Riding Behaviors

While a wide range of bicycle riding behaviors were reported, most participants indicated that they ride a bike 1-2 times per week or more, ride between 1-5 miles/week, ride a bike for pleasure, and ride in both a rural and an urban area. It is noteworthy that 16 percent of participants had a history of a bike accident that required medical attention. Table 5 summarizes the bicycle-riding behaviors of the study participants.

Table 5

Bicycle Riding Behaviors of Study Sample

Frequency of riding a bike when the weather permits (N = 458)	
Weekly	
1-2 times/week	80 (17.5%)
3-4 times/week	59 (12.9%)
5-7 times/week	59 (12.9%)
Monthly	
1-2 times/month	119 (26.0%)
Yearly	
1-2 times/year	141 (30.8%)
Distance of riding a bike (N = 444)	
<1 mile/week	156 (35.1%)
1-5 miles/week	193 (43.5%)
> 5 miles/week	95 (21.4%)
Reason for riding a bike (N = 512)	
For pleasure	229 (44.7%)
To commute to work/school	89 (17.4%)
Both for pleasure and to commute	194 (37.9%)
Location of riding a bike (N = 513)	
In a rural area	89 (17.3%)
In an urban area	190 (37.0%)
Both a rural area and an urban area	234 (45.6%)
History of a bike accident that required medical treatment (N = 544)	
Yes	87 (16.0%)
No	457 (84.0%)

Helmet Use, Demographic Factors, and Bicycle Riding Behaviors

Chi-square tests for association were conducted to analyze the relationship between demographic characteristics and helmet use; see Figure 2. There was a significant association between age and helmet use (defined as participants in the Action and Maintenance SOC); $\chi^2(2, n = 542) = 18.29$, $p < .001$, *Cramer's V* = .18. Of those respondents age 18 to 22 years, 21.8 percent reported consistent helmet use. Of those respondents age 23 to 29 years, 34.2 percent reported consistent helmet use. Of those respondents age 30 to 59 years, 47.1 percent reported consistent helmet use. There was no significant association between gender and helmet use (26.5 percent of male respondents and 25.4 percent of female respondents consistently wear a helmet); χ^2 (1, *n* = 543) = .036, *p* = .85, *phi* = .013. There was no significant association between years of education completed and helmet use; χ^2(2, *n* = 515) = 1.41, *p* = .49, *Cramer's V* = .052.

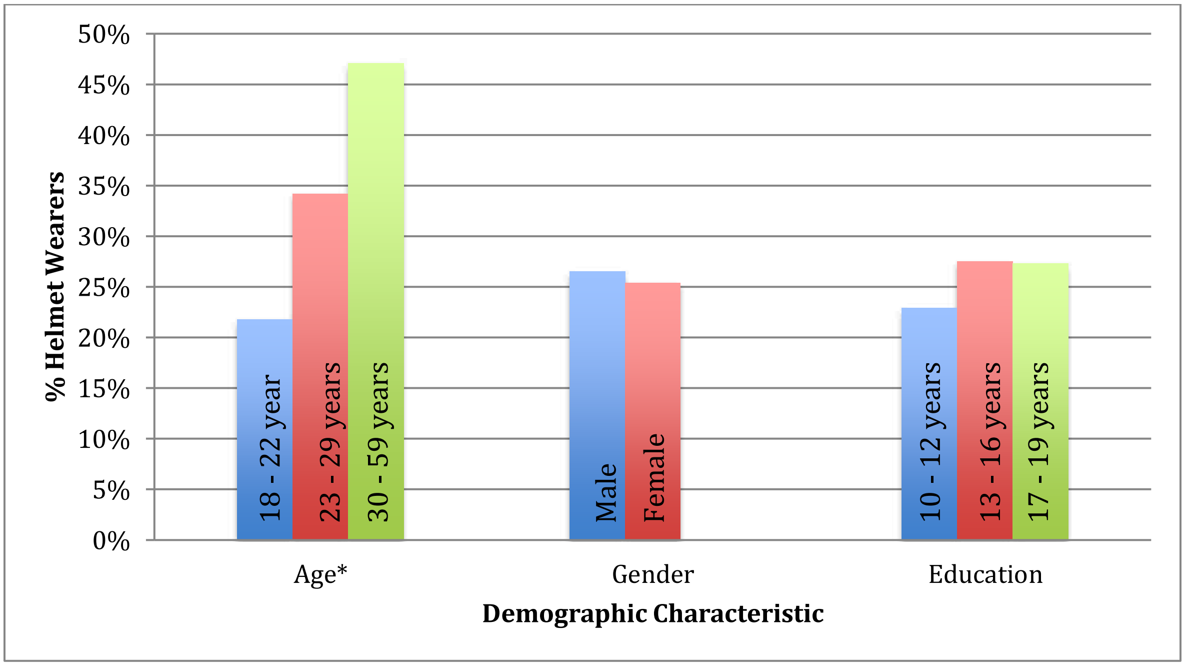


Figure 2. Demographic characteristics of participants and helmet use. There was a significant association between demographic characteristics indicated with * and helmet use (*p*<.05).

Chi-square tests for association were conducted to analyze the relationship between bicycle-riding behaviors and helmet use; see Figure 3. There was a significant association between distance of bike ride and helmet use, χ^2(2, *n* = 444) = 7.26, *p* = .027, *Cramer's V* = .13. Of those who ride > 5 miles per week, 37.9 percent consistently wear a helmet; of those who ride 1 – 5 miles/week, 24.4 percent consistently wear a helmet; of those who ride <1 miles/week, 23.7 percent consistently wear a helmet. There was also a significant association between bike riding purpose, χ^2(2, *n* = 512) = 11.53, *p* = .003, *Cramer's V* = .150. Of those who ride for pleasure, 31.9 percent consistently wear a helmet; of those who ride to commute to work/school, 13.5% consistently wear a helmet; of those who ride both for pleasure and to commute, 24.7 percent consistently wear a helmet. There was no significant association between helmet use and frequency of bike riding (weekly, monthly, yearly); $\chi^2(2, n = 458) = 1.64, p = .44$, *Cramer's V* = .060. Finally, there was no significant association between helmet use and location of bike ride (rural, urban, both urban and rural); $\chi^2(2, n = 513) = .71, p = .70$, *Cramer's V* = .037.

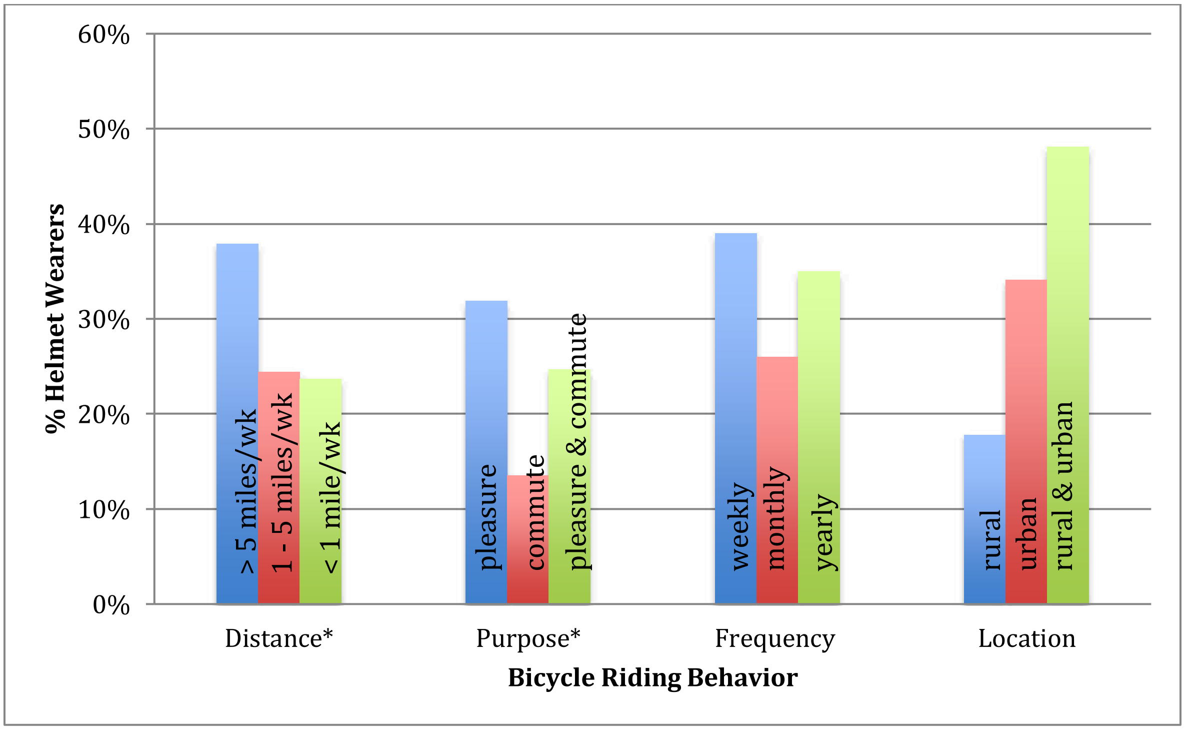


Figure 3. Bicycle riding behaviors of participants and helmet use. There was a significant association between behaviors indicated with * and helmet use ($p<.05$).

There was a significant association between history of a bike accident that required medical treatment and helmet use, $\chi^2(1, n = 544) = 8.55, p = .003$, *phi* = .131. Of those who had been in a bike accident that required any level of medical treatment, 39.1 percent reported consistent helmet use; of those who have not been in such accident, 23.4 percent reported consistent helmet use (Figure 4).

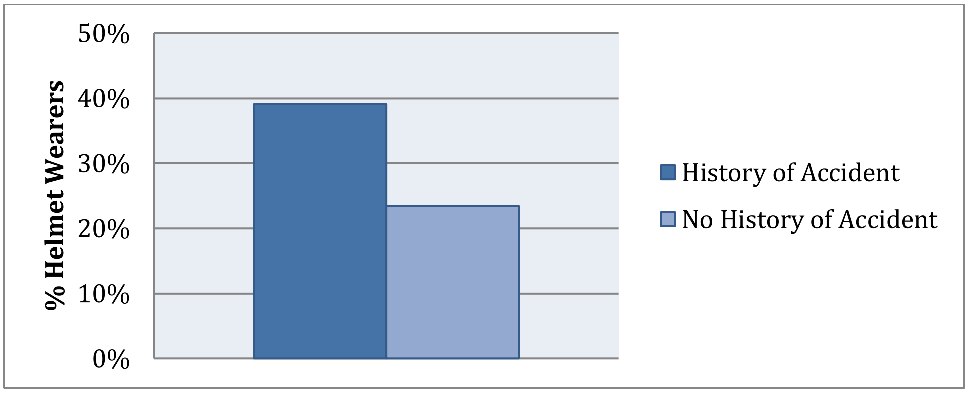


Figure 4. History of bike accident that required medical attention and helmet use of participants.

SOC Classification

Valid participants (N=547) were placed in each SOC based on self-reported helmet use behaviors, as indicated by their response to the following question: *Do you consistently wear a helmet when you ride a bicycle?* Of the total participants, 25.8% of respondents consistently wear a helmet when they ride a bicycle. While 20.3% of helmet non-wearers are thinking about wearing a helmet in the future, the majority of participants (53.9%) does not consistently wear a helmet and are not thinking about wearing a helmet in the future (Figure 5).

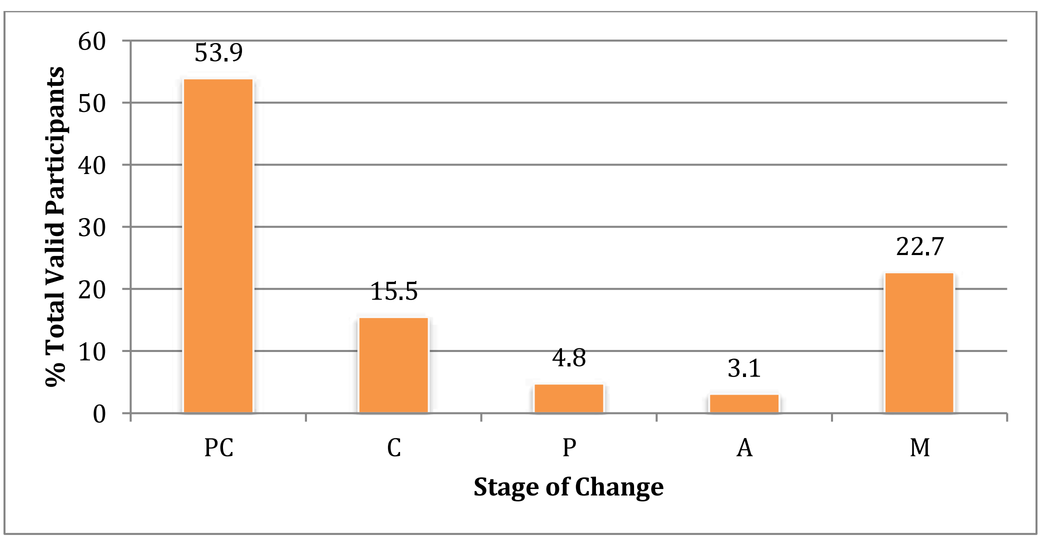


Figure 5. SOC classification based on response to SOC question. PC = Precontemplation, C = Contemplation, P = Preparation, A = Action, M = Maintenance.

Analyses of TTM Constructs Across SOC

The means and standard deviations of all the DVs (the TTM Constructs: Decisional Balance Construct [PRO/CON], Self-Efficacy Construct [CONFIDENCE/TEMPTATION], Processes of Change Construct [EXPERIENTIAL/BEHAVIORAL]) were calculated for all participants across each level of the IV (Stage of Change; Table 6). Subsequent analyses are described by TTM Construct; please see Appendix G for a summary of the mean differences and effect sizes for post hoc comparisons for all six dependent variables.

Table 6

Means (Standard Deviations) of the Dependent Variables Across SOC

Construct	DV	SOC				
		PC	C	P	A	M
Decisional Balance	PRO	4.11 (0.78)	4.42 (0.66)	4.64 (0.33)	4.74 (0.39)	4.69 (0.60)
	CON	2.80 (0.94)	2.50 (0.90)	2.36 (0.79)	2.01 (0.94)	2.11 (0.81)
Self-Efficacy	CONFIDENCE	2.38 (0.96)	3.16 (0.83)	2.97 (0.77)	3.88 (0.84)	3.97 (0.85)
	TEMPTATION	3.26 (1.11)	2.80 (0.80)	2.89 (0.92)	2.09 (0.93)	2.02 (0.90)
Processes of Change	EXPERIENTIAL	2.24 (0.69)	3.05 (0.75)	2.95 (0.66)	3.36 (0.75)	3.49 (0.75)
	BEHAVIORAL	1.52 (0.58)	2.32 (0.79)	2.33 (0.73)	3.07 (0.86)	3.27 (0.81)

Note. Experiential processes include Conscious Raising, Dramatic Relief, Environmental Reevaluation, Self Reevaluation, and Social Liberation; Behavioral processes include Counter-Conditioning, Helping Relationships, Self Liberation, Stimulus Control, and Reinforcement Management.

Decisional Balance Construct. To address hypotheses 1 through 5 of this study, the relationship between the Decisional Balance construct (Pros and Cons of helmet use) and helmet-use behavior was investigated with the following comparisons: (1) standardized PRO and CON values (T scores) across SOC groups; (2) PRO scores across SOC groups (one-way Welch

ANOVA); and (3) CON scores across SOC groups (one-way ANOVA). In addition, item analyses explored the mean values placed on individual PRO and CON statements.

Comparison of standardized PRO and CON scores across SOC groups. For comparison to previous research and to each other, the PRO and CON variables were converted to standardized T scores (M = 50, SD = 10) for each SOC. These standardized means were plotted across SOC to explore the value of the Decisional Balance construct when individuals progress from the Precontemplation SOC to the Maintenance SOC (Figure 6).

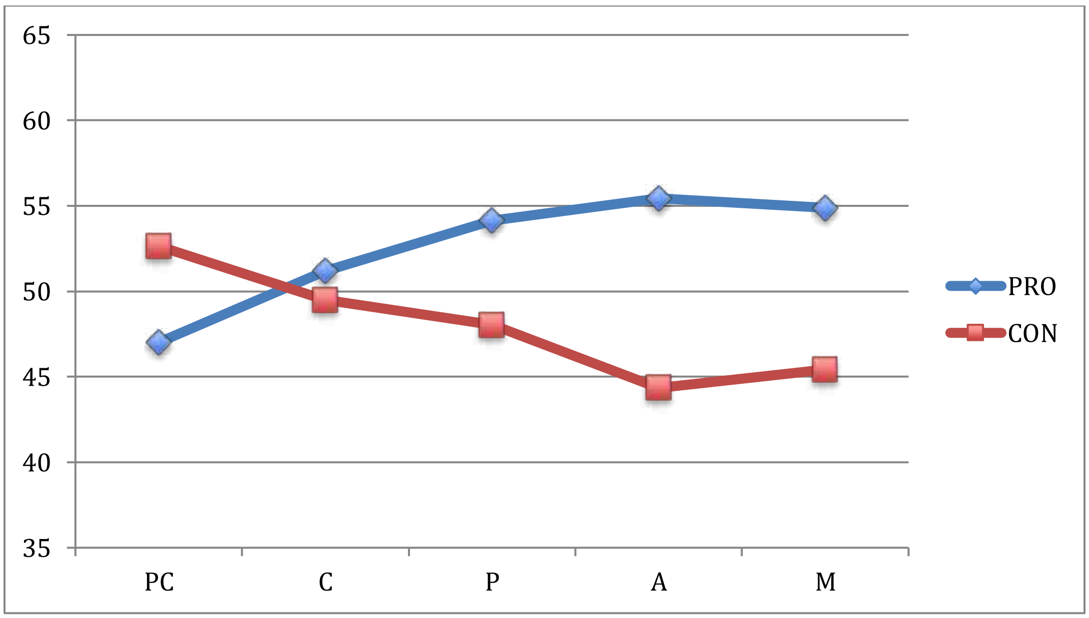


Figure 6. The mean values of the Pros and Cons of helmet use (in T scores) by SOC.

There was a marked pattern of change in the weighting of the importance of the Pros and Cons by participants at different stages. The Cons of wearing a helmet (e.g., wearing a helmet is uncomfortable) were higher than the Pros of wearing a helmet (e.g., helmets decrease head injuries*)* for individuals in the Precontemplation SOC (T [CON] = 52.64, T [PRO] = 47.01). For participants in the Contemplation SOC, the Pros of helmet use (T = 51.19) were slightly higher than the Cons of helmet use (T = 49.49). This trend of the Pros of helmet use being higher than the Cons of helmet use continued for participants in the Preparation SOC (T [PRO] = 54.15, T

[CON] = 48.04), and the difference was most distinct in the Action SOC (T [PRO] = 55.44, T [CON] = 44.35). This trend of the Pros being higher than the Cons of helmet use continued for participants in the Maintenance SOC (T [PRO] = 54.88, T [CON] = 45.51).

Comparison of PRO scores across SOC groups. A one-way ANOVA was conducted to examine if participants in SOC group (Groups PC, C, P, A, M) differ with respect to their reported value placed on the PROs of helmet use. Outliers were included in the analysis because comparison of a one-way ANOVA on original data and the transformed data suggested that the results would not be materially affected. Homogeneity of variances was violated, as assessed by Levene's test for equality of variances ($p < .001$). As such, the *Welch's* F test was used. With Bonferroni correction ($p < .0083$), the one-way ANOVA of the mean PRO scores revealed a statistically significant main effect, *Welch*'s $F(4, 80.870) = 22.897$, $p < .001$. The estimated omega squared ($\omega^2 = .14$) indicated a large effect size, suggesting that approximately 14 percent of the total variation in mean PRO score is attributable to differences between the five stages of change.

Post-hoc comparisons, using the Games-Howell post hoc procedure ($p < .05$), were conducted to determine which pairs of the five SOC groups differed significantly. These results are given in Table 7, and revealed that participants in Group PC (M=4.11, SD = .78) had a significantly lower mean score on the measure of the Pros of helmet use than participants in Group C (M = 4.42, SD = .66; $p = .003$),Group P (M = 4.64, SD = .33; $p < .001$), Group A (M = 4.74, SD = .39; $p < .001$), and Group M (4.69, SD = .60; $p < .001$).Participants in Group C had a significantly lower mean PRO score than participants in Group M ($p = .044$).See Table 7and Figure 7.

Table 7

Post Hoc Results for PRO Scores by SOC Group

SOC	Mean (SD)	Mean Differences (Effect Sizes, Cohen's *d*)				
		PC (n=291)	C (n=84)	P (n=26)	A (n=16)	M (n=122)
PC	4.11 (.78)	_ _ _				
C	4.42 (.66)	-.31* (.43)	_ _ _			
P	4.64 (.33)	-.53*(.88)	-.22	_ _ _		
A	4.74 (.39)	-.63*(1.02)	-.32	-.099	_ _ _	
M	4.69 (.60)	-.59* (.83)	-.28* (.43)	-.053	.046	_ _ _

*Note.***p*<.05

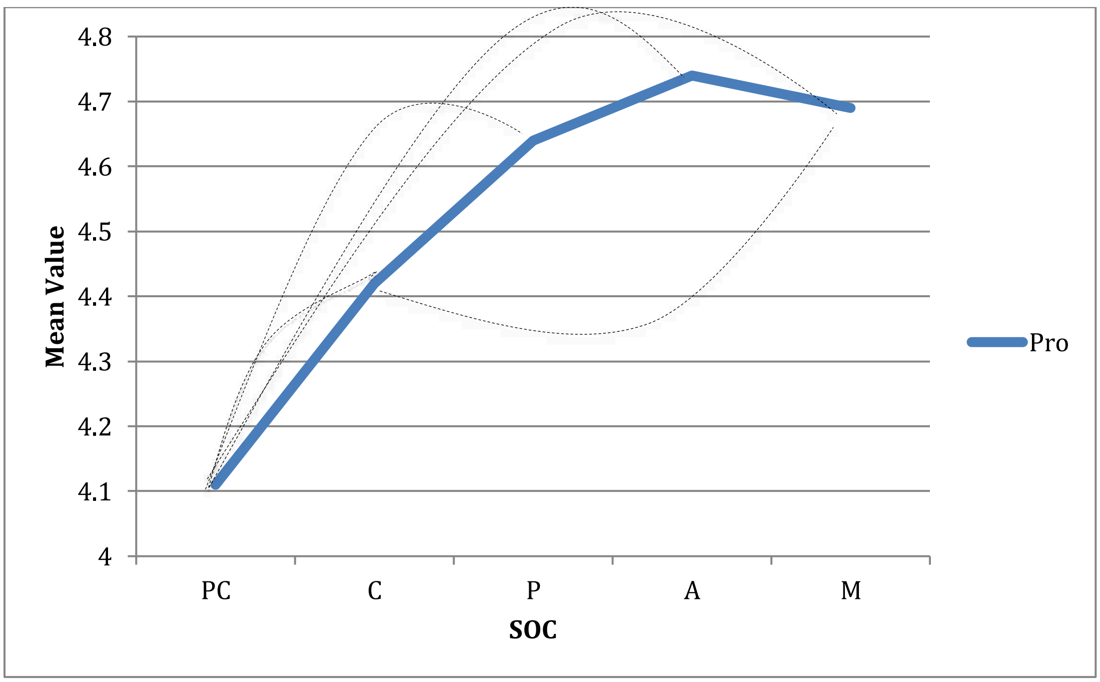


Figure 7. Difference in Mean PRO Scores by SOC Group. A dashed line represents significant differences at the $p < .05$ level in the Games-Howell post-hoc analysis.

Comparison of CON scores across SOC groups. A one-way ANOVA was conducted to examine if participants in SOC group (Groups PC, C, P, A, M) differ with respect to their reported value placed on the Cons of helmet use. An outlier was included in the analysis because comparison of a one-way ANOVA on original data and the transformed data suggested that the results would not be materially affected. There was homogeneity of variances, as assessed by

Levene's test for equality of variances (p=.281). With Bonferroni correction (p< .0083), the one-way ANOVA of the mean CON score revealed a statistically significant main effect, $F\ (4, 536) = 14.82,\ p < .001$. The partial eta squared ($\eta 2$ = .10) indicated a medium effect size, suggesting that approximately 10 percent of the total variation in mean CON score is attributable to differences between the five stages of change.

Post-hoc comparisons, using the Tukey HSD test (p< .05), were conducted to determine which pairs of the five SOC groups differed significantly. These results are given in Table 8, and revealed that participants in the Group PC (M = 2.80, SD = .94) had a significantly greater mean score on the measure of the Cons of helmet use than participants in Group A (M = 2.01, SD = .94; p = .005) and Group M (M = 2.11, SD = .81; p< .001). Participants in Group C (M = 2.50, SD = .90) had a significantly higher mean CON score than participants in Group M (p = .019). See Table 8 and Figure 8.

Table 8

Post Hoc Results for CON Scores by SOC Group

SOC	Mean (SD)	Mean Differences (Effect Sizes, Cohen's *d*)				
		PC (N= 292)	C (N= 84)	P (N= 25)	A (N= 17)	M (N= 123)
PC	2.80 (.94)	___				
C	2.50 (.90)	.30	___			
P	2.36 (.79)	.44	.14	___		
A	2.01 (.94)	.79* (.84)	.49	.35	___	
M	2.11 (.81)	.69* (.79)	.39* (.46)	.25	-.10	___

*Note.**p* <.05

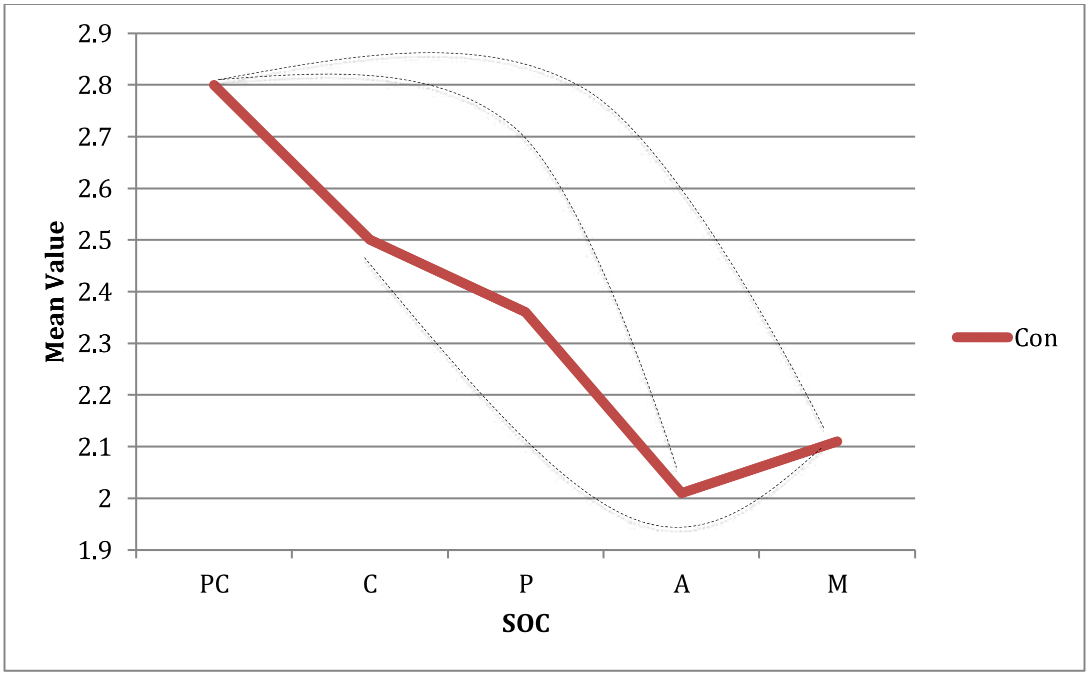


Figure 8. Difference in Mean CON Scores by SOC Group. A dashed line represents significant differences at the $p < .05$level in the Tukey HSD post-hoc analysis.

Importance placed on Pro and Con statements. Item analyses were conducted to compare the mean score of each Pro and each Con item in the Decisional Balance questionnaire, despite SOC (Table 10). While these results should be interpreted cautiously as some item means are very close in value, it is still interesting to note patterns and compare to previous research (Hammond & Hall, 2015). Overall results indicated that the Pros of helmet use were rated as more important than the Cons of helmet use. Decreasing head injury and safety from cars were rated as the most important Pros of helmet use, while being uncomfortable and people teasing someone who wears a helmet were rated as the most important Cons of helmet use.

Table 9

Mean Scores on Each Item of the Decisional Balance Construct

	Decisional Balance Questionnaire Item	N	Min.	Max.	Mean	Std. Deviation
PROS	Helmets decrease head injuries.	541	1	5	4.77	0.68
	Helmets help protect me while sharing the road with cars.	547	1	5	4.56	0.91
	Wearing a helmet is a good choice.	547	1	5	4.35	0.88
	Smart riders wear helmets.	547	1	5	4.24	1.02
	I feel safer when I wear a helmet while riding a bike.	545	1	5	3.72	1.30
CONS	Wearing a helmet is uncomfortable.	547	1	5	3.07	1.33
	People tease people who wear helmets.	543	1	5	2.54	1.33
	Wearing a helmet will mess up my hair.	547	1	5	2.47	1.44
	Wearing a helmet makes it less fun to ride a bike.	545	1	5	2.39	1.31
	Helmets cost more than I am willing to pay.	545	1	5	2.29	1.34

Self-Efficacy Construct. To address hypotheses 6 through 10 of this study, the relationship between the Self Efficacy construct (Confidence and Temptation) and helmet behavior was investigated with the following comparisons: (1) standardized CONFIDENCE and TEMPTATION values (T scores) across SOC Groups; (2) CONFIDENCE scores across SOC Groups (one-way ANOVA); and (3) CON scores across SOC Groups (one-way Welch ANOVA). In addition, item analyses compared the values placed on individual Confidence and Temptation statements, regardless of SOC. The mean Confidence and Temptation ratings during specific aspects of situations that may impact one's confidence to wear a helmet were also explored.

Comparison of standardized CONFIDENCE and TEMPTATION scores across SOC groups. For comparison to previous research and to each other, the CONFIDENCE and

TEMPTATION variables were converted to standardized T scores (M = 50, SD = 10) for each SOC. These standardized means were plotted across SOC to explore the value of the Self-Efficacy constructs when individuals move from the Precontemplation SOC to the Maintenance SOC (Figure9).

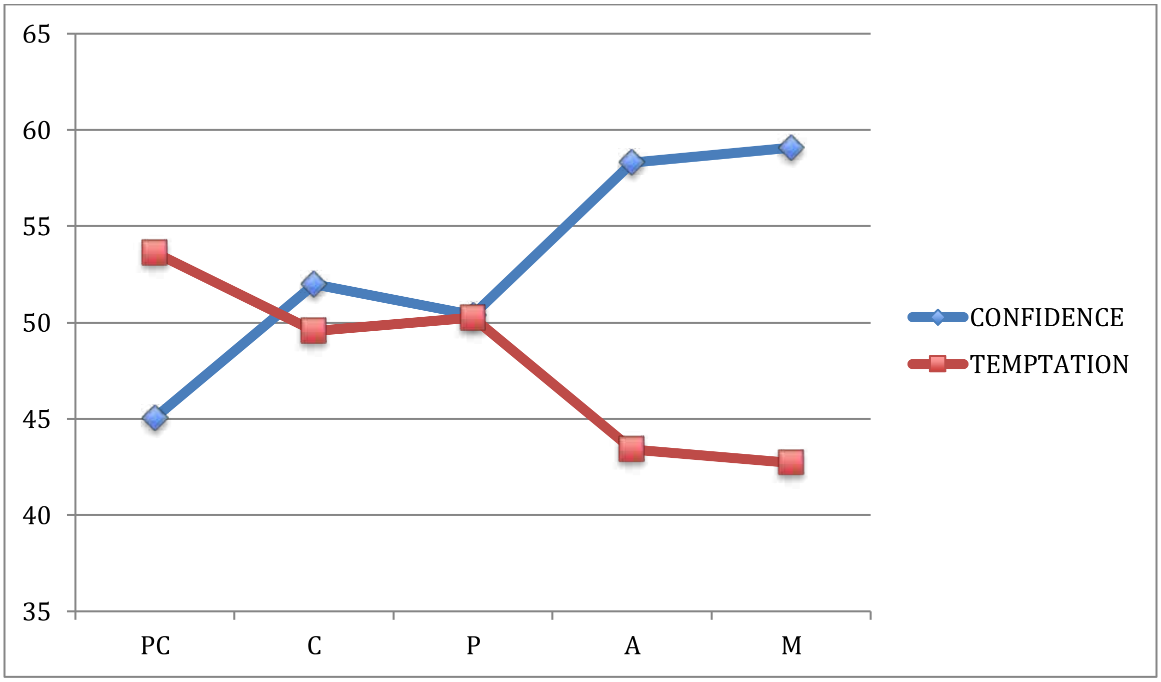


Figure 9. The mean values of the CONFIDENCE and TEMPTATION of helmet use (in T scores) by SOC.

There was a marked pattern of change in the experiences of Confidence and Temptation at different stages. The feelings of Confidence to wear a helmet in specific situations (e.g., when I think my helmet use behaviors are not a problem, when the weather is rainy or snowy) were lower than the feelings of Temptation to not wear a helmet in the same situations for individuals in the Precontemplation SOC (T [CONFIDENCE] = 45.06, T [TEMPTATION] = 53.63). For participants in the Contemplation SOC, the feelings Confidence to wear a helmet (T = 51.99) were slightly higher than the feelings of Temptation to not wear a helmet (T = 49.56). Participants in the Preparation SOC indicated similar levels of Confidence to wear a helmet (T =

50.39) than feelings of Temptation to not wear a helmet (T=50.25). The difference was most distinct in the Action SOC (T [CONFIDENCE] = 58.31, T [TEMPTATION] = 43.41). This trend of feelings of Confidence being higher than feelings of Temptation continued in the Maintenance SOC (T [CONFIDENCE] = 59.08, T [TEMPTATION] = 42.71).

Comparison of CONFIDENCE scores across SOC groups. A one-way ANOVA was conducted to examine if participants in SOC group (Groups PC, C, P, A, M) differ with respect to their reported levels of CONFIDENCE to wear a helmet. Outliers were included in the analysis because comparison of a one-way ANOVA on original data and the transformed data suggested that the results would not be materially affected. There was homogeneity of variances, as assessed by Levene's test for equality of variances (p =.204). With Bonferroni correction (p< .0083), the one-way ANOVA of the mean CONFIDENCE scores revealed a statistically significant main effect, $F\ (4, 492) = 67.28, p < .001$. The partial eta squared ($\eta 2$ = .35) indicated a large effect size, suggesting that approximately 35 percent of the total variation in mean CONFIDENCE score is attributable to differences between the five stages of change.

Post-hoc comparisons, using the Tukey HSD (p< .05) test, were conducted to determine which pairs of the five SOC groups differed significantly. These results are given in Table 10, and revealed that participants in Group PC (M = 2.38, SD = .96) had a significantly lower mean score on the measure of CONFIDENCE to wear a helmet than participants in Group C (M = 3.16, SD = .83;p< .001), Group P (M = 2.97, SD = .77; p= .021), Group A (M = 3.88, SD = .84;p< .001) and Group M (M = 3.97, SD = .85; p< .001). Participants in Group C had a significantly lower mean CONFIDENCE score than participants in Group A (p=.031) and Group M (p< .001). Participants in Group P had a significantly lower mean CONFIDENCE score than participants in Group A (p= .019) and Group M (p< .001). Table 10 and Figure 10.

Table 10

Post Hoc Results for CONFIDENCE Scores by SOC Group

SOC	Mean (SD)	Mean Differences (Effect Sizes, Cohen's *d*)				
		PC (n=267)	C (n=79)	P (n=23)	A (n=16)	M (n=112)
PC	2.38 (.96)	– – –				
C	3.16 (.83)	-.78 (.87)	– – –			
P	2.97 (.77)	-.60* (.68)	.18	– – –		
A	3.88 (.84)	-1.50* (1.66)	-.72* (.86)	-.91* (1.13)	– – –	
M	3.97 (.85)	-1.59* (1.75)	-.81* (.96)	-.99* (1.23)	-.09	– – –

*Note.***p* <.05

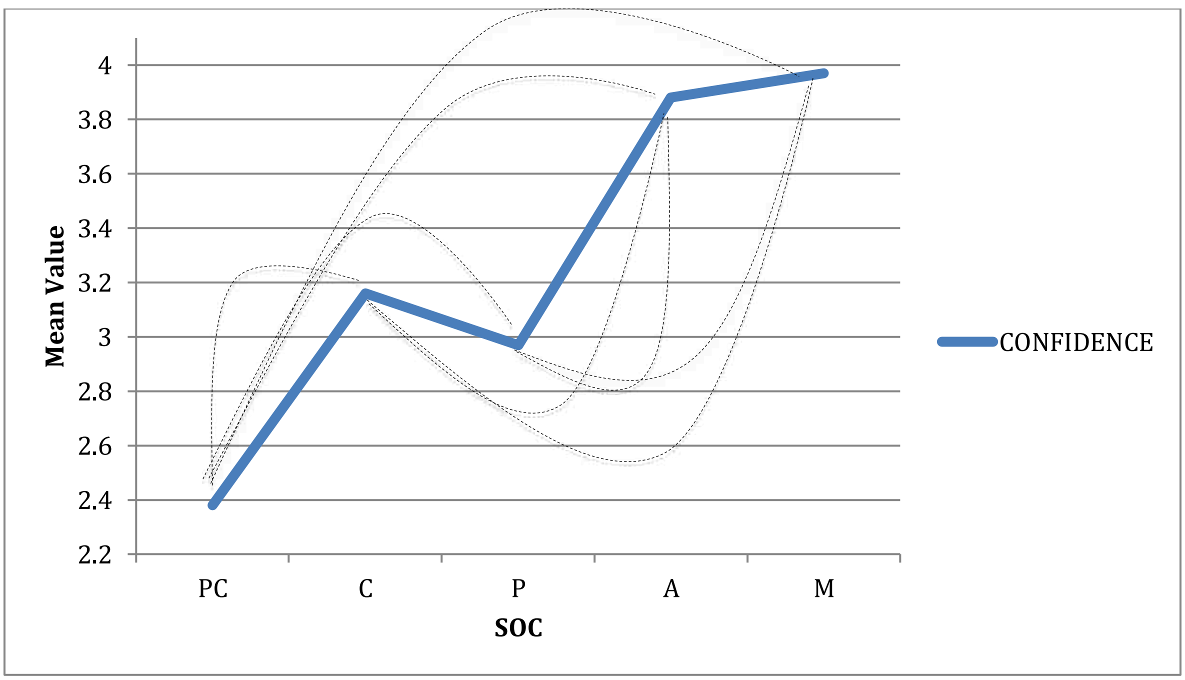


Figure 10. Difference in Mean CONFIDENCE Scores by SOC Group. A dashed line represents significant differences at the *p* <.05 level in the Tukey HSD post-hoc analysis.

Comparison of TEMPTATION scores across SOC groups*.* A one-way ANOVA was conducted to examine if participants in SOC group (Groups PC, C, P, A, M) differ with respect to their reported levels of TEMPTATION to not wear a helmet. Outliers were included in the analysis because comparison of a one-way ANOVA on original data and the transformed data suggested that the results would not be materially affected. Homogeneity of variances was violated, as assessed by Levene's test for equality of variances (p= .012). As such, the *Welch's* F test was used. With Bonferroni correction (p< .0083), the one-way ANOVA of the mean TEMPTATION scores revealed a statistically significant main effect, Welch's F(4, 72.386) = 33.575, p< .001. The estimated omega squared (ω^2 = .21) indicated a large effect size, suggesting that approximately 21 percent of the total variation in mean TEMPTATION score is attributable to differences between the five stages of change.

Post-hoc comparisons, using the Games-Howell post hoc procedure (p< .05), were conducted to determine which pairs of the five SOC groups differed significantly. These results are given in Table 11, and revealed that participants in Group PC (M = 3.26, SD = 1.11) had a significantly higher mean score on the measure of TEMPTATION to not wear a helmet than participants in Group C (M = 2.80, SD = .80;p = .001), Group A (M = 2.09, SD = .93; p = .001), and Group M (M = 2.02, SD = .90;p< .001).Participants in Group M had significantly lower mean TEMPTATION scores than participants in Group C (p<.001)and Group P (M = 2.89, SD = .92; p = .002). See Table11 and Figure 11.

Table 11

Post Hoc Results for TEMPTATION Scores by SOC Group

SOC	Mean (SD)	Mean Differences (Effect Sizes, Cohen's *d*)				
		PC (n=265)	C (n=79)	P (n=24)	A (n=17)	M (n=112)
PC	3.26 (1.11)	_ _ _				
C	2.80 (.80)	.46* (.48)	_ _ _			
P	2.89 (.92)	.37	-.09	_ _ _		
A	2.09 (.93)	1.17*(1.14)	.71	.80	_ _ _	
M	2.02 (.90)	1.24*(1.23)	.78* (.92)	.87* (.96)	.07	_ _ _

*Note.***p* <.05

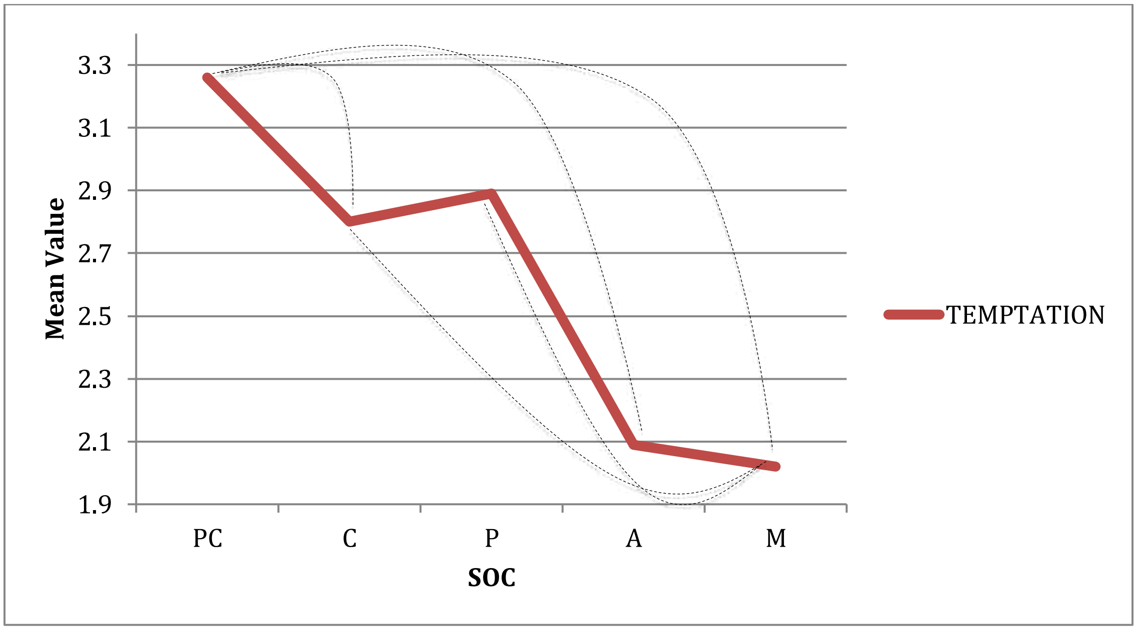


Figure 11. Difference in mean TEMPTATION Scores Across SOC.A dashed line represents significant differences at the $p < .05$ level in the Games-Howell post hoc analysis.

Importance of the Self-Efficacy items for helmet use. The mean value placed on individual CONFIDENCE and TEMPTATION statements, regardless of SOC, was also considered. Item analyses were conducted to compare the mean score of each CONFIDENCE item and each TEMPTATION item in the Self-efficacy questionnaire. While these results should be interpreted cautiously as some item means are very close in value, results may suggest meaningful patterns and information about when individuals feel most confident to wear a helmet, and when they feel most tempted to not wear a helmet. The five situations in which participants reported the greatest levels of Confidence and the lowest levels of Confidence to wear a helmet, and the five situations in which participants reported the greatest levels Temptation and the lowest levels of Temptation to not wear a helmet, are described in Table 12 (see Appendices H, I, and J for the mean and standard deviations for all of the Confidence and Temptation items from the Self-Efficacy questionnaire).

Table 12

Highest and Lowest Confidence and Temptation Ratings from the Self-Efficacy Scale

	Self-Efficacy Questionnaire Item	*N*	Mean	SD
Confidence to wear a helmet	**Situations with Highest Ratings**			
	When I am exposed to information about helmet use or brain injury prevention. (Environmental Cues)	*529*	*3.84*	*1.39*
	When other people encourage me to wear a helmet. (Social Cues)	*532*	*3.68*	*1.39*
	When my helmet is easy to access. (Environmental Cues)	*535*	*3.68*	*1.41*
	When I am with friends who are wearing a helmet. (Social Cues)	*532*	*3.61*	*1.45*
	When the weather is rainy or snowy. (Environmental Cues)	*531*	*3.58*	*1.47*
	Situations with Lowest Ratings			
	When I only have to ride a short distance. (Environmental Cues)	*527*	*2.24*	*1.46*
	When I have a strong urge to not wear a helmet. (Habit Situations)	*525*	*2.37*	*1.49*
	When I am in a rush. (Environmental Cues)	*527*	*2.40*	*1.49*
	When I am with friends who are not wearing a helmet. (Social Cues)	*526*	*2.42*	*1.47*
	When I think it is okay to not wear a helmet just one time (Habit Situation)	*525*	*2.46*	*1.46*
Temptation to not wear a helmet	**Situations with Highest Ratings**			
	When I only have to ride a short distance. (Environmental Cues)	*531*	*3.54*	*1.60*
	When I think it is okay to not wear a helmet just one time. (Habit Situations)	*528*	*3.54*	*1.52*
	When I have a strong urge to not wear a helmet. (Habit Situations)	*529*	*3.52*	*1.60*
	When I am in a situation that I have not worn a helmet in the past. (Habit Situations)	*526*	*3.35*	*1.58*
	When I am with friends who are not wearing a helmet. (Social Cues)	*533*	*3.23*	*1.56*
	Situations with Lowest Ratings			
	When I am exposed to information about helmet use or brain injury prevention. (Environmental Cues)	*518*	*2.13*	*1.37*
	When I am with friends who are wearing a helmet. (Social Cues)	*526*	*2.21*	*1.38*
	When other people encourage me to wear a helmet. (Social Cues)	*526*	*2.22*	*1.33*
	When the weather is rainy or snowy. (Environmental Cues)	*519*	*2.29*	*1.42*
	When my helmet is easy to access. (Environmental Cues)	*523*	*2.30*	*1.40*

Importance of Self-Efficacy items based on situation. The mean ratings of Confidence and Temptation during five specific aspects of situations (positive and negative affect, habit situations, environmental cues, and social cues) that may impact one's confidence to wear a helmet and temptation to not wear a helmet were compared. Respondents indicated similar levels of Confidence and Temptation in Positive Affect Situations and Negative Affect Situations. Participants endorsed the greatest amount of Temptation in habit situations; habit situation was also the only situation that participants indicated higher levels of Temptation than Confidence. Participants indicated the highest Confidence and the least Temptation in Environmental Cue situations (Figure 12; See Appendix I for the mean CONFIDENCE and TEMPTATION rating for each item of the Self-Efficacy construct grouped by situation).

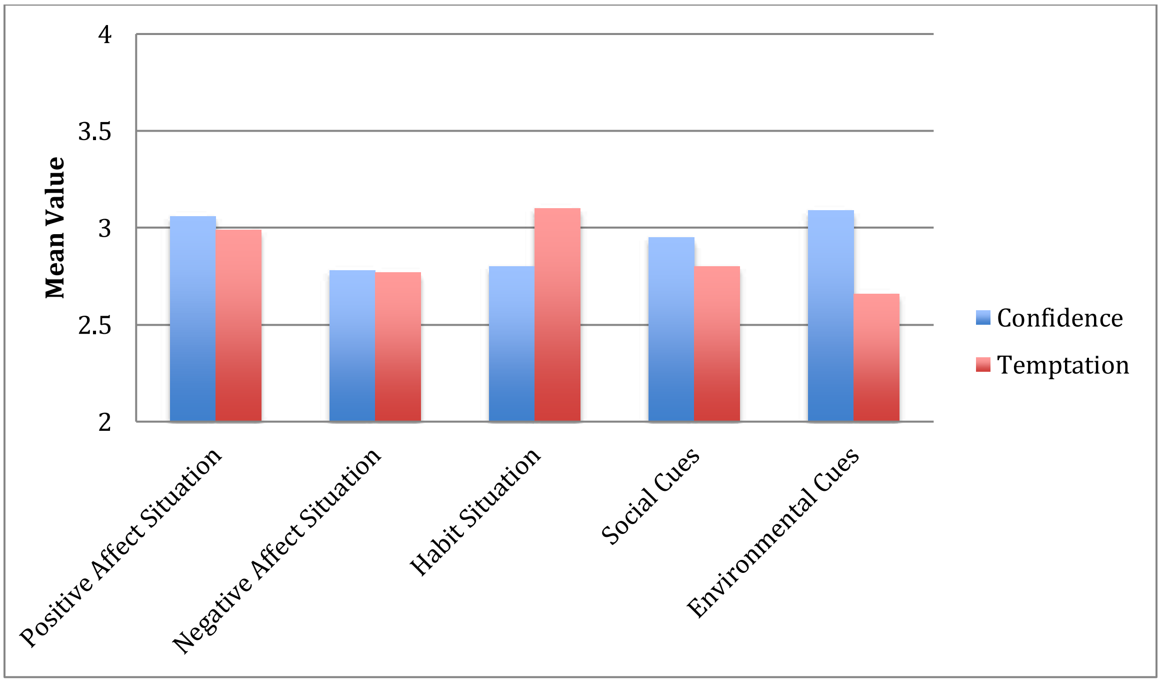


Figure 12. Mean value of CONFIDENCE and TEMPTATION score for all respondents based on situation.

Processes of Change Construct. To address hypotheses 11 through 14 of this study, the relationship between the Processes of Change construct (Experiential processes and Behavioral processes) and helmet-use behavior was investigated with the following comparisons: (1) standardized EXPERIENTIAL and BEHAVIORAL values (T scores) across SOC Groups; (2) EXPERIENTIAL scores across SOC groups (one-way ANOVA); and (3) BEHAVIORAL scores across SOC groups (one-way Welch ANOVA). In addition, item analyses compared the values placed on individual Experiential and Behavioral processes, regardless of SOC. Standardized individual Processes of Change scores across SOC were also explored.

Comparison of standardized EXPERIENTIAL and BEHAVIORAL scores across SOC groups. For comparison to previous research and to each other, the EXPERIENTIAL and BEHAVIORAL variables were converted to standardized T scores (M = 50, SD = 10) for each SOC. These standardized means were plotted across SOC to explore the value of the Processes of Change constructs when individuals move from the Precontemplation SOC to the Maintenance SOC (Figure 13).

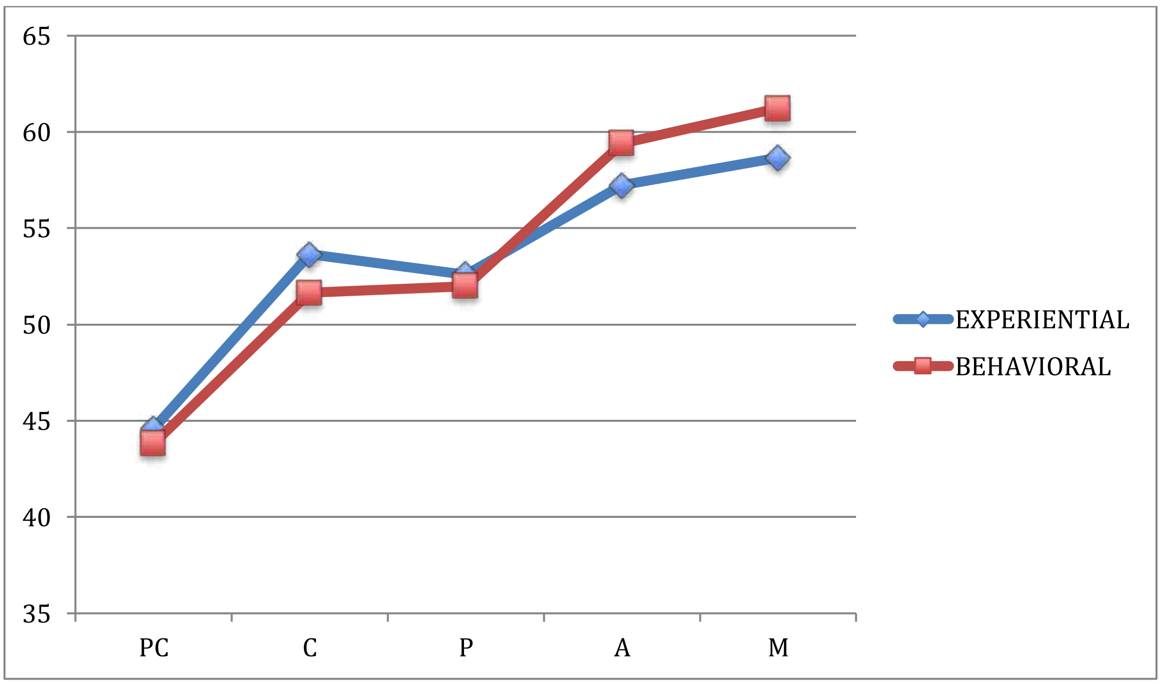


Figure 13. The mean values of the EXPERIENTIAL and BEHAVIORAL Processes of Change with regard to helmet use (in T scores) by SOC.

There was a marked pattern of change in the frequency of experiencing Experiential (e.g., I have heard that bicycle helmet use reduces the risk of brain injury) and Behavioral (e.g., I keep a bicycle helmet conveniently located to remind me to wear a helmet) Processes of Change by participants across SOC. Overall, the use of Experiential and Behavioral processes increased with stage progression. While results should be interpreted cautiously due to the similar progression of the Experiential and Behavioral values across stages, data trends suggest that Experiential processes are used slightly more than Behavioral processes in the earlier stages, with a crossover at the Preparation SOC (T[EXPERIENTIAL] = 57.24, T [BEHAVIORAL] = 59.41), followed by slightly more use of Behavioral processes in the later stages.

Comparison of EXPERIENTIAL scores across SOC groups. A one-way ANOVA was conducted to examine if participants in SOC group (Groups PC, C, P, A, M) differ with respect to their reported use of the EXPERIENTIAL Processes of Change regarding helmet use. Outliers were included in the analysis because comparison of a one-way ANOVA on original data and the transformed data suggested that the results would not be materially affected. There was homogeneity of variances, as assessed by Levene's test for equality of variances (p =.439). With Bonferroni correction ($p < .0083$), the one-way ANOVA of the mean EXPERIENTIAL score revealed a statistically significant main effect: $F(4, 511) = 73.332, p < .001$.The partial eta squared ($\eta 2$ = .37) indicated a large effect size, suggesting that approximately 37 percent of the total variation in mean EXPERIENTIAL score is attributable to differences between the five stages of change.

Post-hoc comparisons, using the Tukey HSD test ($p < .05$), were conducted to determine which pairs of the five SOC groups differed significantly. These results are given in Table 13, and revealed that participants in the Group PC (M = 2.24, SD = .69) had a significantly lower mean score on the measure of the EXPERIENTIAL Processes of Change than participants in Group C (M = 3.05, SD = .75;p<.001), Group P (M = 2.95, SD = .66; p< .001), Group A (M = 3.36, SD = .75 ;p<.001), and Group M (M = 3.49, SD = .75; p<.001). Participants in Group M had a significantly higher mean EXPERIENTIAL score than participants in Group C ($p< .001$) and Group P ($p = .006$). See Table 13and Figure 14.

Table 13

Post Hoc Results for EXPERIENTIAL Scores by SOC Group

SOC	Mean (SD)	Mean Differences (Effect Sizes, Cohen's *d*)				
		PC (N= 276)	C (N= 81)	P (N= 26)	A (N= 17)	M (N= 116)
PC	2.24 (.69)	___				
C	3.05 (.75)	-.81* (1.12)	___			
P	2.95 (.66)	-.71* (1.05)	.10	___		
A	3.36 (.75)	-1.13* (1.55)	-.32	-.41	___	
M	3.49 (.75)	-1.25* (1.73)	-.44* (.59)	-.53*(.76)	-.12	___

*Note.**p* <.05

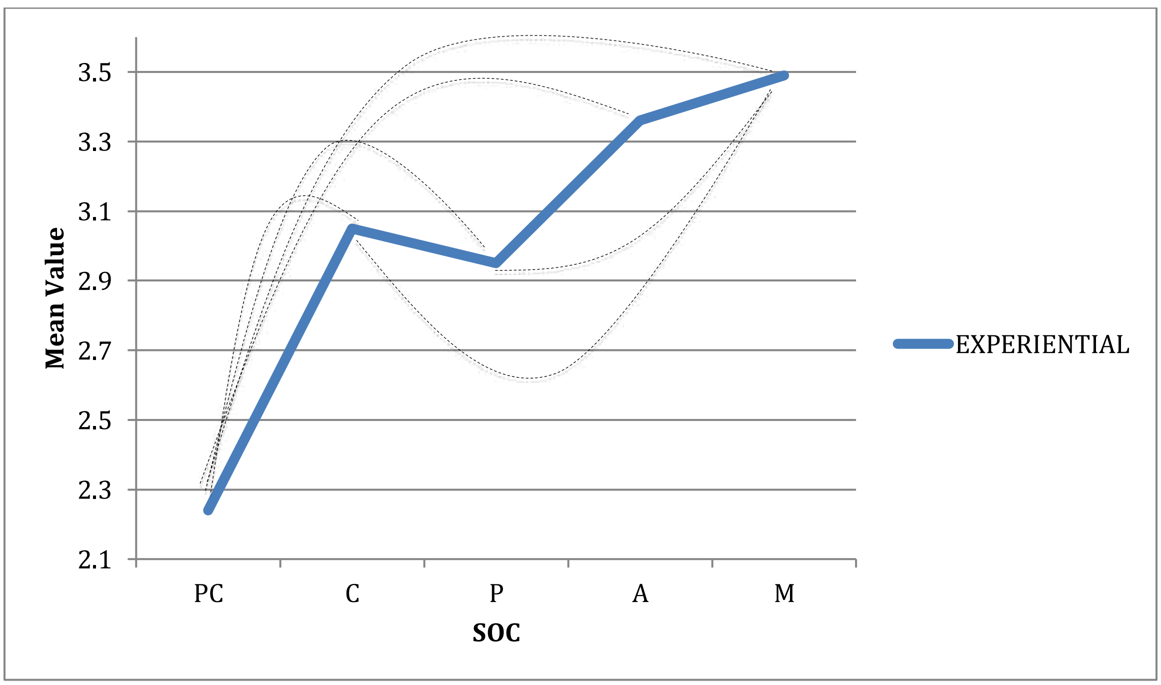


Figure 14. Difference in Mean EXPERIENTIAL Scores Across SOC.A dashed line represents significant differences at the *p* <.05 level in the Tukey HSD post hoc analysis.

Comparison of BEHAVIORAL scores across SOC groups. A one-way ANOVA was conducted to examine if participants in SOC group (Groups PC, C, P, A, M) differ with respect to their reported use of BEHAVIORAL Processes of Change regarding helmet use. Outliers were included in the analysis because comparison of a one-way ANOVA on original data and the transformed data suggested that the results would not be materially affected. Homogeneity of variances was violated, as assessed by Levene's test for equality of variances ($p < .001$). As such, the *Welch's* F test was used. With Bonferroni correction ($p < .0083$), the one-way ANOVA of the mean BEHAVIORAL scores revealed a statistically significant main effect, Welch's $F(4, 70.473) = 129.372$, $p < .001$. The estimated omega squared ($\omega^2 = .49$) indicated a large effect size, suggesting that approximately 49 percent of the total variation in mean BEHAVIORAL score is attributable to differences between the five stages of change.

Post-hoc comparisons, using the Games-Howell post hoc procedure ($p < .05$), were conducted to determine which pairs of the five SOC groups differed significantly. These results are given in Table 14, and revealed that participants in Group PC($M = 1.52$, $SD = .58$; $p < .001$) had a significantly lower mean score on the measure of the BEHAVIORAL Processes of Change than participants in Groups C ($M = 2.32$, $SD = .79$; $p < .001$), P ($M = 2.33$, $SD = .73$; $p < .001$), A ($M = 3.07$, $SD = .86$; $p < .001$), and M ($M = 3.27$, $SD = .81$; $p < .001$). Participants in Group A had a significantly higher mean BEHAVIORAL score than participants in Group C ($p = .023$) and Group P ($p = .046$). Participants in Group M had a significantly higher mean BEHAVIORAL score than participants in Group C ($p < .001$) and Group P ($p < .001$). See Table 14 and Figure 15.

Table 14

Post Hoc Results for BEHAVIORAL Scores by SOC Group

SOC	Mean (SD)	Mean Differences (Effect Sizes, Cohen's *d*)				
		PC (n=288)	C (n=83)	P (n=26)	A (n=17)	M (n=118)
PC	1.52 (.58)	_ _ _				
C	2.32 (.79)	-.81* (1.15)	_ _ _			
P	2.33 (.73)	-.81* (1.23)	-.01	_ _ _		
A	3.07 (.86)	-1.56* (2.11)	-.75*(.91)	-.74*(.93)	_ _ _	
M	3.27 (.81)	-1.76* (2.48)	-.95*(1.19)	-.94*(1.22)	-.20	_ _ _

*Note.**p* <.05

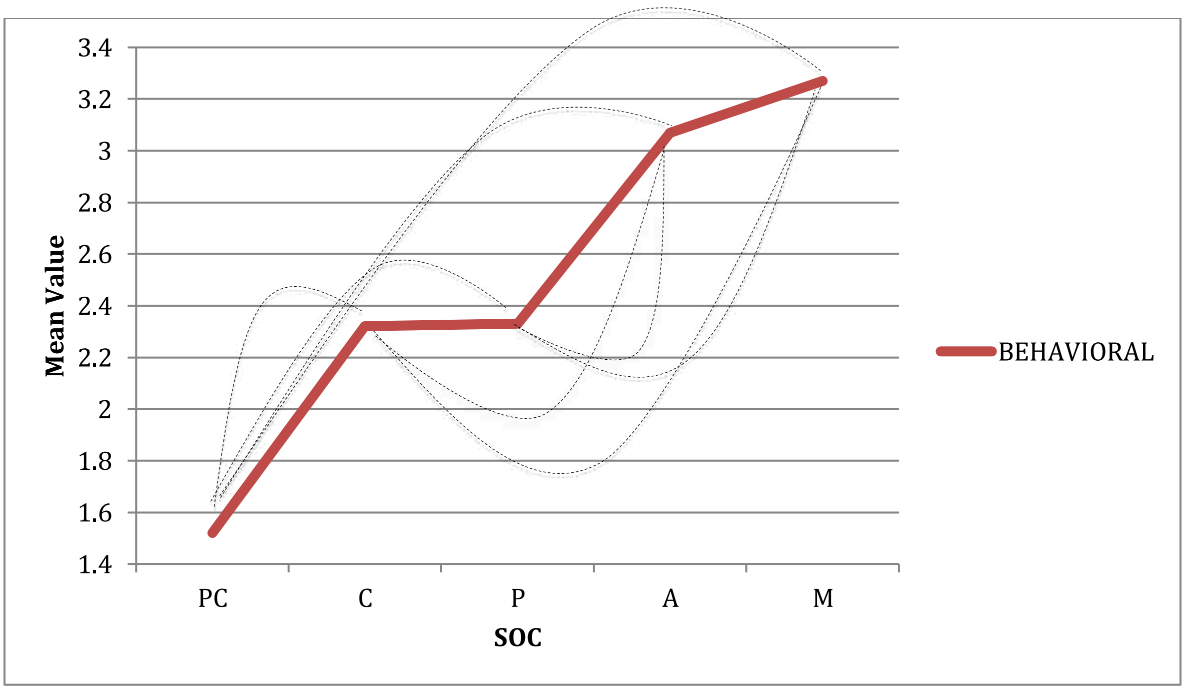


Figure 15. Difference in mean BEHAVIORAL scores across SOC.A dashed line represents significant differences at the p <.05 level in the Games-Howell post hoc analysis.

Importance of the Processes of Change items for helmet use. The mean value placed on the frequency of individual Experiential and Behavioral Processes of Change, regardless of SOC, was also considered. Item analyses were conducted to compare the mean score of the 30 individual items on the Processes of Change scale. Overall results indicate that the Experiential Processes of Change were rated as occurring more frequently than the Behavioral Processes of

Change. While these results should be interpreted cautiously as some item means are very close in value, results may suggest meaningful information and patterns about what cognitive processes individuals are utilizing with regards to helmet use or non-helmet use. The highest endorsed Experiential Processes of Change and the highest endorsed Behavioral Processes of Change are highlighted in Table 15 (see Appendices K and L for the mean and standard deviations for all items from the Processes of Change questionnaire).

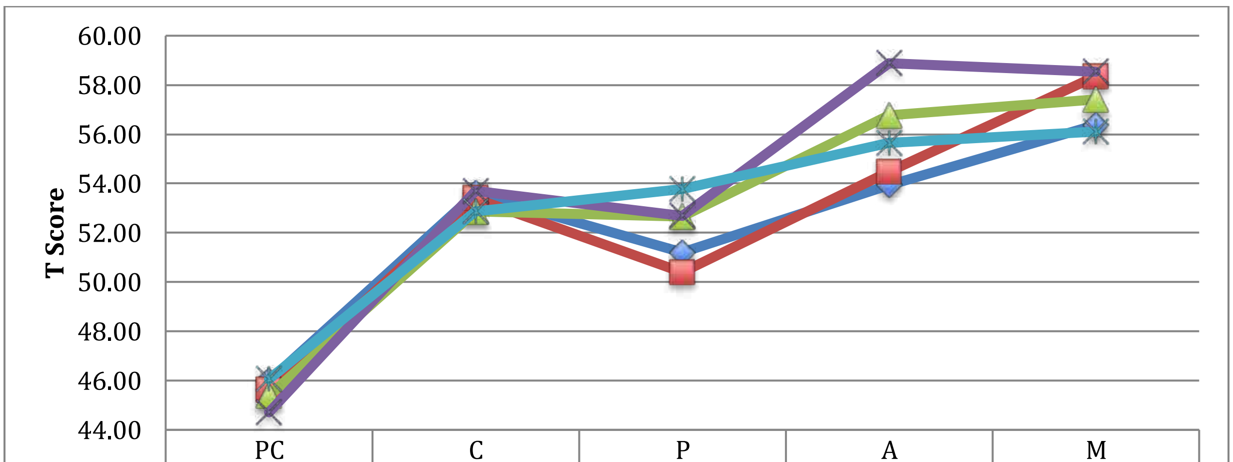
Table 15

Mean Scores of Five Highest Endorsed Experiential and Behavioral Processes of Change

	Questionnaire Item	*N*	Mean	SD
Experiential Processes of Change	I have heard that bicycle helmet use reduces the risk of brain injury (Consciousness Raising)	541	4.10	1.20
	I have found that many people know that wearing a bicycle helmet is good for them. (Social Liberation)	539	3.47	1.34
	I think that regular bicycle helmet use plays a role in reducing health care costs by reducing the risk of brain injury. (Environmental Reevaluation)	543	3.38	1.35
	I am afraid of the consequences to my health if I do NOT wear a bicycle helmet. (Dramatic Relief)	545	2.84	1.19
	I recall information people have given me on the benefits of wearing a bicycle helmet (Consciousness Raising)	542	2.82	1.41
Behavioral Processes of Change	If I engage in regular helmet use, then I feel safer. (Reinforcement Management)	540	2.91	1.49
	I believe that I can wear a bicycle helmet regularly. (Self Liberation)	542	2.85	1.50
	When I am tempted to NOT wear a bicycle helmet, I try to remind myself of the benefits of wearing a helmet. (Counterconditioning)	543	2.52	1.41
	I make sure that I always have access to a bicycle helmet when I plan to ride a bike. (Stimulus Control)	543	2.25	1.43
	Instead of wearing a hat or nothing on my head when I ride a bicycle, I wear a helmet. (Counterconditioning)	542	2.24	1.45

Comparison of standardized individual Process of Change scores across SOC groups. Standardized (T score) analyses were used to compare the mean rating of the 10 individual processes across SOC. Overall, individuals in the Precontemplation SOC reported less process use than the other stages, while individuals in the Preparation and Action stages reported the greatest process use.

Respondents in the earlier stages relied more on Experiential processes (Conscious Raising, Dramatic Relief, Environmental Reevaluation, Self Reevaluation, Social Liberation; see Figure 16) than Behavioral processes. The most distinct increase in use of these processes is between the Precontemplation and Contemplation stages. Social Liberation is the most used by individuals in the Preparation stage (T=53.77), but is the least used in Maintenance (T=56.11). In contrast, Dramatic Relief is the least used by individuals in the Preparation SOC (50.38), and one of the most used in the Maintenance stage (T = 58.35).

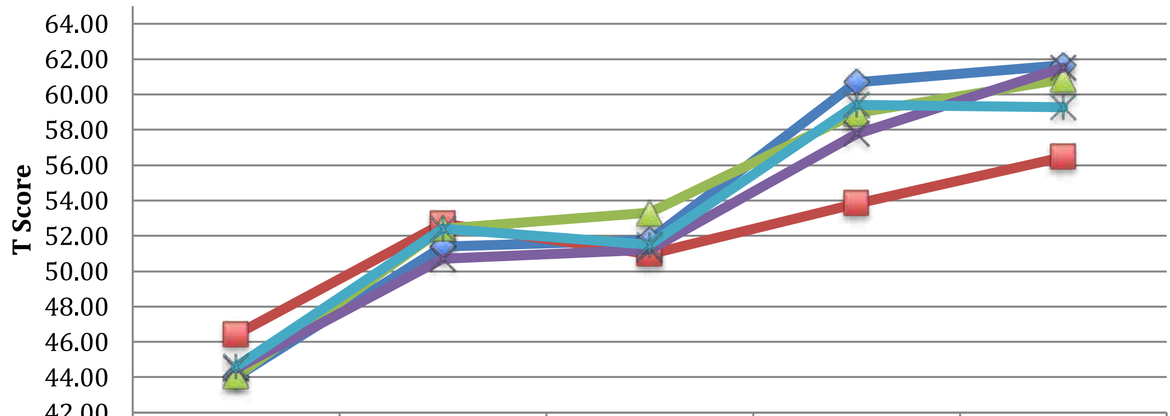


	PC	C	P	A	M
CR	45.99	53.60	51.19	53.94	56.38
DR	45.63	53.39	50.38	54.47	58.35
ER	45.39	52.86	52.65	56.76	57.41
SR	44.71	53.70	52.69	58.88	58.54
SL	46.06	52.87	53.77	55.65	56.11

Figure 16. The mean values of the EXPERIENTIAL Processes of Change with regard to helmet use (in T scores) by SOC. CR = Conscious Raising, DR = Dramatic Relief, ER = Environmental Reevaluation, SR = Self-Reevaluation, SL = Social Liberation.

Respondents in the later stages relied more on Behavioral processes (Counter Conditioning, Helping Relationships, Self Liberation, Stimulus Control, and Reinforcement Management; Figure 17) than Experiential processes. Counterconditioning was lowest in the

Precontemplation SOC (T=44.03) and highest in the Maintenance SOC (T=61.66). In contrast, Helping Relationships was the most highly endorsed Behavioral process in the Precontemplation SOC(T=46.41), and the lowest endorsed Behavioral process in the Maintenance SOC (T=56.46).



	PC	C	P	A	M
CC	44.03	51.39	51.77	60.71	61.66
HR	46.41	52.69	50.96	53.82	56.46
SL2	44.05	52.42	53.31	58.94	60.86
SC	44.49	50.70	51.23	57.76	61.52
RM	44.60	52.39	51.50	59.41	59.27

Figure 17. The mean values of the BEHAVIORAL Processes of Change with regard to helmet use (in T scores) by SOC. CC = Counter Conditioning, HR = Helping Relationships, SL2 = Self-Liberation, SC = Stimulus Control, RM = Reinforcement Management.

Discussion

This novel research used all four constructs of Prochaska and DiClemente's TTM of behavior change (Stages of Change, Decisional Balance, Self-Efficacy, and Processes of Change) to conceptualize and assess bicycle helmet use behaviors in college-aged individuals. This study also analyzed the relationships between bicycle helmet use and demographic characteristics, bicycle-riding behaviors, and past experiences.

Helmet Use, Demographic Factors, and Bicycle Riding Behaviors

Overall, a low rate of participants indicated consistent helmet use when they ride a bike (25.8%). The majority of respondents (53.9%) indicated that they do not consistently wear a helmet and they are not thinking about wearing a helmet in the future. These helmet use rates are similar to those reported in the literature, ranging from 12 percent (Ross et al., 2010), to 16 percent (Weiss, Okun, & Quay, 2004), to 20-25 percent (NHTSA, 2008), to 23.1 percent (Hammond & Hall, 2015). Despite over 10 years of intervention since these rates were published, it does not appear that impactful change has occurred in bicycle helmet use behaviors during the past decade. This suggests a disparity between brain injury prevention efforts and individual bicycle helmet use behaviors. For example, there has been an increase in sports-related brain injury awareness and protection during the past decade through youth protection acts and media coverage (e.g., the impact of repetitive concussions among NFL players), yet minimal change in helmet use for bicycle riding, which represents the largest category of sports-related head injuries (AANS, 2011).Indeed, it appears that messages designed to impact helmet use behavior change, such as brain injury awareness campaigns and public health interventions, have been ineffective during the past decade, creating minimal impetus for behavioral change.

There was a significant association between reported helmet use and age, with older participants reporting more consistent helmet use. Factors such as personal experience, desire to model helmet use for a child, or decreased concern about the evaluation of peers may contribute to this finding of increased helmet use with age. This is an interesting finding, as published helmet use rates often highlight decreased helmet use with age when comparing children (17 years and younger) to adults (18 years and older; e.g., Bolen, Kresnow, & Sacks, 1998; Jewett, Beck, Taylor, & Baldwin, 2016). Yet, consistent with the current research, closer examination of these studies show that age subsets of 18 to 24 years and 18 to 29 years had lower rates of helmet use than older participants. Therefore, helmet use rates comparing children (17 years and younger) and adults (18 years and older) may be unintentionally concealing important information about low rates of helmet use among college-aged individuals as compared to older adults. A more in depth analysis of helmet use base rates among age cohorts is recommended to improve estimates of helmet use among the college-aged population.

There was also a significant association between helmet use and bike riding distance, with those who ride great than 5 miles each week reporting more consistent helmet use. This may suggest that individuals who ride more miles are more invested in bicycling through bike riding resources (e.g., more expensive helmet with enhanced comfort and style) and established bike riding habits (e.g., designated, easily accessible place to store their helmet). In turn, these resources and habits may counteract the highest rated Con of helmet use highlighted in this research (*Wearing a helmet is uncomfortable*) and support a highly-endorsed Process of Change identified in this research (*I make sure that I always have access to a bicycle helmet when I plan to ride a bike*). More consistent helmet use among participants who ride great than 5 miles each week may also reflect the misperception of decreased risk of bike accident when only riding a short distance. For example, previous research found that none of the participants who consistently wore a helmet agreed with the statement "When riding around home or short distances, I do not need to wear a helmet," yet 60 percent of participants who did not wear a helmet agreed with this statement (Kakefuda, 2008). Page et al. (1996) identified "riding long distances" as one of the top circumstances participants reported that they were most likely to wear a helmet.

There was a significant association between helmet use and bike riding purpose. This is an important finding, as commuters may be at an increased risk of collision due to close proximity with cars, yet only 13.5 percent of commuters reported regular helmet use. These findings are consistent with previous research and recommendations that increasing helmet use among college students while commuting should be a primary intervention goal (Kakefuda, Stallones, & Gibbs, 2008). These findings may suggest that "helmet hair" impacts this population's decision to not wear a helmet, and highlight how societal norms that promote a well-kept appearance at work and/or school (as compared to recreational activities) may interfere with neurological injury prevention. Thus, messages that promote a change in personal views regarding normative expectations surrounding helmet hair (e.g., the personal belief that others are prepared to have a negative evaluation of us if we do not follow this norm because we have "helmet hair") and promote resources that offer direct interventions to address this concern (e.g., sharing the website page "19 Hairstyles You Can Wear Under Your Bike Helmet" during an intervention) may be especially effective for the commuting population.

Individuals with a history of a bike accident that required medical attention reported significantly higher rates of helmet use. As suggested by theories of information processing and risk communication research, message recipients highly value their personal experiences with the topic at hand, and personal relevance may increase 'central routes of information processing' that stimulate individual cognitive evaluation of the pros and cons of an issue (Petty, Cacioppo, & Schumann, 1983). Ultimately, this form of information processing leads to more permanent behavior change, as compared to 'peripheral routes of information processing' that are based on cues in the context of persuasion, such as attitude change in response to recommendations from an expert. Accordingly, individuals who have experienced a bike injury, or know someone who has sustained a bike injury or brain injury, may be more receptive to personal reflection of their attitudes in response to helmet promotion messages. Personal experience with a bike injury may also counteract sources of individual risk misconception identified in other behaviors, such as the immunity fallacy(used to explain high rates of safety-seat misuse, suggesting that parents have a reduced perception of risk for motor vehicle injury to their children; Will, 2005) and misperceptions of risk due to low base rates of an event (Kassin, Fein, & Markus, 2010).Future research should examine the possible impact of such factors on helmet use among the college-aged population.

Application of the TTM to Helmet Use Behaviors

Conceptually, this study had three general hypotheses related to the application of the TTM to helmet use behavior: participants in SOC groups (Groups PC, C, P, A, M) would differ with respect to their reported value placed on the Pros and Cons of helmet use (Decisional Balance construct), levels of Confidence to wear a helmet and Temptation to not wear a helmet (Self-Efficacy construct),and use of Experiential and Behavioral Processes of Change (Processes of Change construct) with regard to helmet use. These general hypotheses were all supported.

These findings suggest that helmet use SOC placement is associated with different levels of engagement with factors identified by the TTM to be critical for behavior change. This is consistent with the application of TTM constructs to other health behaviors, such as smoking cessation and exercise program adherence (Maibach & Cotton, 1995; Nigg & Courney, 1998; Velicer et al., 1998). These findings underscore the importance of the current study, as it was designed to address concerns noted in the literature that research often does not account for all four TTM constructs (Hutchison et al, 2009). In turn, this leads to faulty interventions because all dimensions of the TTM should be used together to explain behavior change (Bridle et al., 2005).

Effect size estimates were a particularly interesting finding in the current study, suggesting that the Processes of Change construct accounted for the largest magnitude of difference between the five stages, followed by the Self-Efficacy construct, and then the Decisional Balance construct. Effect size estimates between adjacent stage combinations also provided novel information, suggesting that Experiential and Behavioral processes and Confidence to wear a helmet accounted for the largest magnitude of difference between participants in the Precontemplation and Contemplation stages. Furthermore, effect size estimates suggest that Confidence and Behavioral processes accounted for the largest magnitude of difference between participants in the Preparation and Action stages.

In accordance with the theoretical relationships proposed in the literature regarding the application of TTM to behavior change, specific hypotheses were proposed for each TTM construct as applied to helmet use. These results are discussed below, with emphasis on the application of the findings to helmet use interventions.

Decisional Balance Construct. It was hypothesized that participants who are actively preparing to wear a helmet (Preparation SOC) and participants who started to wear a helmet in the past 6 months (Action SOC) would rate the Pros of helmet use as significantly more important than participants who are not considering helmet use behavior change within the next 6 months (Precontemplation and Contemplation stages). Partial support was provided for these hypotheses, as individuals in the Preparation and Action SOC rated the Pros of helmet use as significantly more important than participants in the Precontemplation SOC. These results suggest that individuals who are actively choosing to wear a helmet place higher value on the benefits of helmet use (e.g., *Helmets decrease head injuries*, *Helmets protect the rider from cars*), and that an emphasis on these benefits will support stage progression. The sharpest increase in value placed on the Pros in adjacent stages was between Precontemplation and Contemplation. This highlights the important role of the weighing of the benefits of helmet use when one begins to contemplate helmet use. These finding align with the pattern identified in a meta-analysis of TTM application to physical activity and exercise (Marshall & Biddle, 2001).

Consistent with application of the TTM to other health behaviors, these findings suggest that interventions should target increasing the Pros of helmet use to support early stage progression (Prochaska et al., 1994). Johnson et al. (2008) found that the Pros of changing must increase nearly twice as much as the Cons must decrease for behavior change to occur; thus, twice as much emphasis should be placed on increasing the benefits of the behavior change. For example, a person who is not considering helmet use (Precontemplation) is more likely to view perceived discomfort of a helmet as a smaller barrier if he or she can identify five benefits of a helmet, compared to another person in the Precontemplation SOC who can only identify one benefit of wearing a helmet. Similar messages should be integrated into helmet promotion interventions (e.g., information about how helmets reduce the risk of brain injuries by up to 88% [Thompson et al., 1999] and information about the importance for protection against factors that the biker cannot control, such as the driver of a car), especially for individuals in the early stages.

As predicted, there was not a significant difference in the importance placed on the Pros of helmet use by participants in the Action and Maintenance stages. This may indicate that continual weighing of the importance of the Pros and Cons are necessary to maintain helmet use, and is consistent with the pattern seen in acquisition of other health behaviors (Velicer et al., 1998). This finding underscores the need for effective information processing in helmet promotion messages to increase the likelihood of stable change. Interventions that stimulate diligent consideration of personal attitudes in relation to the benefits of helmet, regardless of a participant's current SOC, may be critical for the ongoing weighing of the benefits of helmet use required in the Maintenance SOC. In contrast, persons who initiate helmet use based on contextual cues (e.g., wearing a helmet because an expert on brain injury told them to wear a helmet, without parallel reflection on personal attitudes about helmet use) may be at risk for relapse due to a limited foundation for continued emphasis on the benefits of helmet use in the Maintenance SOC. Future research on the application of the TTM to helmet use should investigate the relationship between the weighing of the Pros and Cons of helmet use and relapse prevention.

It was hypothesized that participants who are not actively considering helmet use behavior change (Precontemplation and Contemplation stages) would rate the Cons of helmet use as significantly more important than individuals in later stages. Partial support was provided for these hypotheses, as individuals in the Precontemplation SOC rated the Cons of helmet use as significantly more important than participants in the Action and Maintenance stages, and individuals in the Contemplation SOC rated the Cons of helmet use as significantly more important than individuals in the Maintenance SOC. These findings highlight how one may place less importance on the Cons of helmet use in transition from "not even thinking about wearing a helmet" to regular helmet use. This pattern is generally consistent with the relationship between SOC and the value placed on Cons of behavior change demonstrated in the application of the TTM to other health related behaviors (e.g., Prochaska et al., 1994; Velicer et al., 1998).

Helmet promotion messages should focus on decreasing the importance placed on Cons of helmet use, such as the most salient Cons identified in this study (*Wearing a helmet is uncomfortable*, *People tease people who wear helmets*, *Wearing a helmet will mess up my hair*). For example, facilitators of helmet interventions should help participants find a comfortable fitting helmet during the intervention. Misperceptions about what other college students think about helmet use should be addressed (e.g., accuracy of the perception that a college student would tease another based on helmet use) and Internet resources that promote hairstyles to address "helmet hair "should be shared during the intervention.

The crossover between the importance placed on the Pros and Cons of helmet use occurred at the Contemplation SOC. Thus, the progression from not even thinking about wearing a helmet (Precontemplation) to thinking about wearing a helmet in the next 6 months (Contemplation) appears to be an important time during which an individual's evaluation of the Pros and Cons of wearing a helmet drastically shifts. This suggests that participants who appear uninterested in the helmet promotion message, and even defensive of their current non-helmet use behavior, may be undergoing an important shift in covert processes (the weighing of the costs and benefits of helmet use) that may lead towards behavior change as they evaluate their perception of the costs and benefits of helmet use. This crossover at the Contemplation SOC is consistent with previous research that applied the Decisional Balance construct to helmet use (Hammond & Hall, 2015), and supports the notion that one will decide the pros of a changing a problem behavior outweigh the cons before taking action (Prochaska et al., 1994). Thus, presenters at helmet interventions should not be discouraged by a display of minimal interest by participants; instead, these participants should be encouraged to actively identify benefits of helmet use through group discussion, instead of the typical noninteractive, prescriptive lecture style format used in mass helmet promotion interventions. This finding is important for helmet promotion efforts, as the current study and previous research (Hammond & Hall, 2015) suggest that the majority of college-aged individuals are in the Precontemplation SOC.

Self-Efficacy Construct. It was hypothesized that current helmet wearers (Action and Maintenance SOC) would report significantly greater levels of Confidence to wear a helmet than non-helmet wearers (Precontemplation, Contemplation, and Preparation stages). Support was provided for these hypotheses, highlighting the important role of the personal belief that one can engage in helmet use, and maintain the behavior despite temptation, for helmet use behavior change. These findings are consistent with previous research that demonstrates increasing self-efficacy with stage progression (Marshall & Biddle, 2001; Prochaska et al., 2005). An interesting finding in the current research was the dramatic difference and large effect size in Confidence between Precontemplation and Contemplation, and between Preparation and Action. This suggests that a certain level of Confidence to wear a helmet is necessary as one begins to consider helmet use, and then another increase in Confidence is necessary to initiate helmet use behavior. To enhance levels of Confidence, interventions should promote helmet use as a challenge that can be mastered, and presenters should engage with participants to identify other health behaviors that they have mastered instead of focusing on limitations to helmet use.

Research has indicated that specific aspects of situations (positive and negative affect, habit situations, environmental cues, and social cues) impact one's Confidence to wear a helmet. Overall, respondents indicated the highest levels of Confidence to wear a helmet in Environmental Cue situations (e.g., *When I am exposed to information about helmet use or brain injury; When my helmet is easy to access*) and in Social Cue situations (e.g., *When other people encourage me to wear a helmet*). Thus, interventions should provide information about helmet use and brain injury, and provide materials for participants that promote continued exposure to this information after the intervention (e.g., handouts with clear messages about the impact of brain injury on the college population, such as the lifetime cost of a brain injury; media messages on campus that promote brain injury awareness and helmet use for an extended time after the intervention). Interventions should encourage participants to identify an easily accessible location for their helmet, and acknowledge how their personal helmet use behaviors are impacted by encouragement from others.

There was no difference in reported levels of Confidence between participants in the Action and Maintenance stages, which was inconsistent with the hypothesized relationship. This finding suggests that a similar level of Confidence is necessary to initiate helmet use behavioral change and to maintain helmet use over time. This finding appears to be consistent with research that has identified the importance of helping increase self-efficacy during the Action and Maintenance stages to promote stable change and avoid relapse (DiClemente, 1991). The current findings may highlight the distinction between different types of self-efficacy (action, maintenance, and recovery) identified with addictive behaviors (Marlatt, Baer, & Quigley, 1995), and suggest that the self-efficacy tool used in this research measured action self-efficacy more than maintenance and recovery self-efficacy. Further exploration into this relationship between confidence and maintenance/relapse of helmet use behaviors is recommended.

It was hypothesized that non-helmet wearers (Precontemplation, Contemplation, and Preparation stages) would report significantly greater levels of Temptation than current helmet wearers (Action and Maintenance SOC). Partial support was provided for these hypotheses, as participants in the Precontemplation stage reported significantly greater levels of Temptation than participants in the Contemplation, Action, and Maintenance stages; the levels of Temptation reported by individuals in the Contemplation and Preparation stages were significantly greater than the Maintenance SOC. These results suggest that helmet use is impacted by one's belief that he or she can use skills to resist temptation to not wear a helmet, and that one experiences increased belief in these skills as he or she progresses across stages. The overall trend of participants reporting greater Confidence and less Temptation with regard to helmet use behaviors as they progress through stages is consistent with previous research that has applied the Self-Efficacy construct to other behaviors (e.g. Huang, Hung, Chang, & Chang, 2009;

Marshall & Biddle, 2001; Prochaska et al., 2005). The only significant difference in Temptation among adjacent stage combinations was between the Precontemplation and Contemplation stages. This may suggest that one experiences a decreased desire to not wear a helmet in certain situations even before they have committed to wearing a helmet. This is an interesting finding, as the greatest decrease in Temptation between stages is conceptualized as occurring closer to action (Velicer et al., 1998).

Respondents indicated the highest levels of Temptation in Environmental Cues situations (e.g., *When I only have to ride a short distance)* and Habit situations (e.g., *When I think my helmet use behaviors are not a problem; When I have a strong urge to not wear a helmet*). Interventions that promote situations that support confidence (e.g., bicycling with others who are wearing helmets, continual exposure to helmet use or brain injury prevention information) while also actively addressing situations that may lead to strong temptation to not wear a helmet (e.g., addressing misconceptions that helmets are not as necessary for a short bicycle ride) may lead to a decrease in levels of Temptation and support movement towards action.

The crossover in feelings of Confidence and Temptation was between the Preparation and Action stages, suggesting that helmet wearing behavior is most likely to occur when one's confidence to wear a helmet surpasses their temptation to not wear a helmet. Indeed, the large effect of Confidence between Preparation and Action suggests that confidence to engage in helmet use is important for behavioral action. This crossover of the Confidence and Temptation before action is consistent with application of the TTM to other health related behaviors (e.g., DiClemente et al., 1985; Marcus, et al., 1992; Velicer et al, 1998). Research has suggested that low self-efficacy is associated with a stronger need for personal contact and guidance, while higher self-efficacy is associated with a desire for less personal, more on demand type of support

(Dahl, Eagle, & Ebrahimjee, 2013). This highlights a critical application to helmet use interventions, which are usually performed in the "mass message," less personal approach; yet, the target participants during these interventions (non-helmet wearers, with lower reported levels of confidence to wear a helmet) may prefer a more personalized style of message delivery. Thus, interventions for individuals in earlier stages could offer personalized follow-up to promote self-efficacy, with regular emails in subsequent months for continued exposure to brain injury and helmet messages. In contrast, less personal media messages, or involvement with a friend who encourages helmet use as needed, may have greater impact on the self-efficacy of current helmet wearers.

Processes of Change Construct. It was hypothesized that helmet wearers (participants in the Action and Maintenance stages) would report significantly less use of the Experiential Processes of Change than non-helmet wearers. In contrast, the findings in this study suggest that the use of Experiential processes are highest in the Action and Maintenance stages, highlighting the continual use of Experiential processes as one begins to contemplate, initiate, and maintain helmet use behaviors. While these findings are inconsistent with research suggesting that the use of Experiential processes usually peak in the earlier stages (Velicer et al., 1998), the current findings are consistent with research suggesting increased application of Experiential processes across all stages (Nigg & Courney, 1998; Prochaska et al., 2005).

Consistent with a meta-analysis of TTM application to physical activity and exercise (Marshall & Biddle, 2001), Consciousness Raising and Social Liberation appear to be important Experiential processes in the early stages of helmet use behavior change. This suggests that information gathering (e.g., raising awareness of the devastating implications of a brain injury and the role of helmets to reduce this risk) and highlighting changing social norms with regard to the importance of concussion prevention should be emphasized for individuals in the early stages. Furthermore, awareness of how others encourage helmet use (e.g., friends, roommates, parents, siblings, etc.) should be promoted. Media channels that provide exposure to this information with relevance to the college population (e.g., message that reads “Want to save 1 million dollars over your lifetime? Wear a helmet every time you ride a bike”) and follow-up distribution of information after the initial intervention (e.g., emails to participants with information about brain injury and helmet use) may be especially effective to address these processes.

Effect size estimates in the current research suggest that the Experiential processes accounted for a large amount of variation between the five stages of change. When comparing differences between adjacent stage combinations, these processes accounted for the largest amount of difference between the Precontemplation and Contemplation stages. This suggests that messages targeting such processes should be integrated into helmet interventions, especially in the earlier stages, to promote consideration of helmet use. For example, emotional reactions to traumatic bike accidents or sustaining a brain injury should be explored, as should the realization that helmet use is consistent with preexisting values and self-image (e.g., importance of health, protection of cognitive abilities and independence relied upon during college). Participants should also be encouraged to acknowledge the negative effect of one’s helmet use behavior on his or her environment (e.g., younger siblings or children may model participant’s non-helmet use behavior).

It was hypothesized that helmet wearers would report significantly greater use of the Behavioral Processes of Change than participants in the earlier stages. Support was provided for these hypotheses, as participants in the Action SOC reported significantly more use of

Behavioral processes than participants in the Precontemplation, Contemplation, and Preparation stages. These findings likely reflect how individuals in the later stages of change (helmet wearers) rely more on environmental controls, commitments, conditioning, and rewards to progress through stages (e.g., having a helmet readily available and wearing a helmet instead of a hat while riding, reaching out to friends who wear helmets to encourage personal helmet use). These findings are generally consistent with research regarding application of the Behavioral Processes of Change to behavior change (Prochaska et al., 2005; Velicer et al., 1998).

Effect size estimates suggest that Behavioral processes accounted for a striking amount of variation between the five stages of change. When comparing differences between adjacent stage combinations, these processes accounted for the largest amount of difference between the Precontemplation and Contemplation stages. This was a meaningful finding, as Behavioral processes are usually regarded as more important in the later stages in the application of the TTM to other health related behaviors. It is important to consider how this finding may contribute to the consistently high rates of college-aged individuals in the Precontemplation SOC. Current helmet promotion interventions, based on assumptions from other health behaviors, may be delivering ineffective messages to individuals in the Precontemplation SOC because important experiences and activities necessary to initiate the consideration of helmet use are not being activated. Thus, messages that focus on making firm commitments to helmet use, establishing rewards and stimulus cues in the environment to promote helmet use, and accessing social supports to encourage helmet use should be emphasized for persons in the early stages. In addition, these messages will likely support progression from Preparation to Action, as the behavioral processes also accounted for a large amount of difference between these stages. A meta-analysis of application of the TTM to physical activity and exercise found this same pattern of process use, suggesting that the progression from Precontemplation to Contemplation, and then Preparation to Action, are the “busiest” stage transitions about the use of processes of change.

The current research identified Helping Relations (seeking and using social support to support helmet use, such as asking a friend or roommate to help monitor one’s helmet use) as the highest endorsed Behavioral process in the Precontemplation SOC, and the lowest endorsed Behavioral process in the Action and Maintenance SOC. The reverse was true for Counter Conditioning. This suggests that while both processes are activated throughout stage progression, individuals rely more on social support in the earlier stages (before actual helmet use behavior activation). Once they are actively engaged in helmet use, they rely more on activities such as substituting helmet use for less safe behaviors (e.g., purchasing a helmet to wear instead of a hat). As such, encouraging participants to ask others to help monitor their helmet use may support earlier stage progression, while follow-up contact with participants to ensure that they are wearing a helmet to increase feelings of safety may support later stage progression.

Overall, application of the Processes of Change construct to helmet use suggests that individuals who are wearing a helmet are not there by chance. Instead, they are actively engaging in and applying Experiential and Behavioral processes that individuals in the earlier stages of change are applying at a lower rate. This highlights the important role of these processes in helmet behavior change, and is consistent with research demonstrating that processes used by individuals at different stages are valuable predictors of behavioral change (Prochaska et al., 1992). For example, research has identified that the Processes of Change used early in treatment were the single best predictor of treatment outcome for weight control (Prochaska, Norcross, Fowler, Follick, & Abrams, 1992). As this is the first study to apply the Processes of Change construct to helmet use, future research should further investigate this relationship.

Summary: Application of the TTM to Helmet Interventions

These findings are in agreement with previous research that supports the modification of interventions for problem behaviors based on the recipient's current SOC (e.g., Marshall & Biddle, 2001; Nigg & Courney, 1998; Noar, Benac, & Harris, 2007; Prochaska et al., 1994). Thus, proposed intervention techniques based on the current study are described. It is recommended that these proposed techniques are embedded into preexisting helmet intervention modalities, such as the ThinkFirst Campaign, to maximize resources and outreach. While the focus of this description is based on a similar educational campaign style (intervention at a college setting with approximately 100 participants), it is essential to note that these techniques can be applied to interventions of all sizes and at a variety of locations. See Appendix M for a summary of the proposed intervention techniques.

The intervention should be facilitated by at least two presenters, usually individuals who work at a local rehabilitation facility. A brain injury survivor may join the presenters to offer personal testimony. At the beginning of the intervention, participants should answer the one-item SOC question. Participants are then separated based on current self-reported SOC; due to likely uneven group sizes, groups may be based on helmet wearers and non-helmet wearers. Email addresses should be collected from all participants for follow-up communication and material distribution. Media sources should be used to engage participants, such as displaying relevant information from the Internet on a large screen. A dynamic presentation style that encourages audience involvement throughout the entire intervention is recommended.

Participants in the early stages receive messages to activate all TTM constructs. A primary goal is to increase awareness of bicycle helmet use. This is accomplished through provision of information about the risk of brain injury while cycling (e.g., cycling represents the largest category of sports-related head injuries [AANS, 2011]; an estimated 327 fatalities, 6900 hospitalizations, and 100,000 ED visits due to bicycle-related brain injuries could have been prevented by one year of universal helmet use [Schulman et al., 2002]). Information about the efficacy of helmet use should also be provided (e.g., helmets can lower the risk of brain injury by up to 88 percent for cyclists; Thompson et al., 1999). Messages should emphasize the Pros of helmet use, such as protection from distracted drivers who are unaware of a bicyclist. A discussion led by the intervention team should encourage participants to actively identify multiple Pros of helmet use.

Activities and experiences to initiate the consideration of helmet use should be heavily integrated into messages for Precontemplaters, such as raising awareness about healthcare costs associated with bicycle-related brain injuries (e.g., estimated $81million direct and $2.3 billion indirect costs related to such injuries in 1997; Schulman et al., 2002).Factors and situations that increase confidence to wear a helmet should be promoted, such as storing a helmet in a visible and easily accessible place and being around others who wear helmets. Helmet use should be promoted as a challenge that one can master, encouraging participants to reflect on health challenges and behavior change they have mastered in the past. Personalized follow-up (e.g., regular emails in subsequent months for continued exposure to brain injury and helmet information) should be utilized at scheduled time points after the intervention (e.g., 1 month, 3 months, 6 months, 1 year). The role of social supports should be noted, encouraging participants to identify people in their life who encourage bicycle safety, helmet use, and brain injury prevention.

Messages to participants in the Contemplation SOC should promote evaluation of the costs and benefits of helmet use and reflect ambivalence. Even uninterested participants should be encouraged to acknowledge the Pros of helmet use, as a covert shift in weighing of the costs and benefits of helmet use may be occurring during this stage progression. Similar to messages offered to Precontemplaters, education about risk reduction provided by helmets and consequences of brain injury should be emphasized; follow-up information to provide continual reminders about the efficacy of bicycle helmets and consequences of brain injury is also recommended. Ideally, this information should relate to the target population (e.g., how a brain injury can negatively impact one's independence and autonomy, which are important values for college students). Information channels that cause an emotional reaction (e.g., personal testimony from a brain injury survivor) should be utilized. Participants should be encouraged to reflect on personal experiences and attitudes regarding helmet use, bicycle accidents, and brain injury.

Participants who are actively considering helmet use (Preparation SOC) should receive messages that promote confidence to wear a helmet through continual exposure to helmet use or brain injury prevention information. Awareness and active discussion of specific situations that promote confidence (e. g., bicycling with others who are wearing helmets) and decrease temptation to not wear a helmet (e.g., encouragement from others to wear a helmet) should be fostered. Activities and experiences that support progression to action should be emphasized, such as committing to helmet use by telling a friend, reflecting on how social norms about brain injury are changing to support brain protection, and putting one's helmet in an accessible, highly visible location. In addition, messages should focus on decreasing the Cons of helmet use through the sharing of resources to address “helmet hair” and an onsite opportunity to try on comfortable helmets.

Participants who are current helmet wearers (Action and Maintenance) should be exposed to continued messages to boost confidence to wear a helmet and resist temptation to not wear a helmet. This may include information about changes in social acceptance of helmet use and accessibility of new helmet designs. Messages should encourage participants to reflect on the impact of their current and past helmet behavior on others (e.g., children), and group processes can be utilized to reinforce helmet use behavioral change (e.g., presenters encourage group recognition of brain injury prevention efforts by individuals in the audience). Messages that increase emotional experiences through personal interactions with a brain injury survivor or exposure to media messages about the negative implications of brain injury should be utilized. Steps to be taken by each participant to promote safety through consistent helmet use should be brainstormed as a group (e.g., storing a helmet in an easily accessible place). A follow-up email from the facilitators one month after the intervention should reinforce the Pros of helmet use, strategies that one can take to promote self-efficacy, and the use of behavioral processes previously discussed within earlier stage interventions.

Notably, this research suggests that the progression from Precontemplation (not even thinking about wearing a helmet) to Contemplation (thinking about wearing a helmet in the next 6 months) is an important time when one is actively engaged in all TTM constructs. Thus, while individuals in the Precontemplation SOC may appear ambivalent and disengaged during helmet interventions, this is a target population for such interventions. This information is important because the current study and previous research (Hammond & Hall, 2015) suggest that the majority of college-aged recipients of helmet interventions are likely in the Precontemplation SOC. Younger age, those who ride less than 1 mile per week, and commuters may be more likely to not wear a helmet; awareness of the relationship with these factors may help interventions target such at risk populations.

Research has suggested that the application of Motivational Interviewing (MI) techniques (e.g., reflective listening, rolling with resistance, eliciting change talk) can effectively support stage progression for other health-related behaviors, such as physical activity (Jackson, Asimakopoulou, & Scammell, 2007), smoking cessation in adolescents (Erol & Erdogan, 2008), and treatment of diabetes (Channon, Smith, & Gregory, 2003). While there are differences between the two approaches, MI and TTM share an emphasis on individualized messages of change, the pros and cons of a behavior change, and elements of "staging" (Resnicow et al., 2002). Indeed, integrating MI techniques into helmet-use interventions may support a presenter's ability to individually engage with and promote change within the audience.

Limitations and Suggestions for Future Research

While this research sought to better understand changes in the constructs of the TTM as one progresses across stages, this was a cross-sectional rather than longitudinal design. Thus, comparison of the DVs at different stages of change was based on different individuals at one time point, not on individuals progressing across stages over time. Future research should pursue a longitudinal study design that measures an individual's views and experiences as measured by the constructs of the TTM over time as they move through stages. Furthermore, future research should seek to understand why some people stop wearing a helmet, even after successfully progressing through the early stages to reach Action and/or Maintenance (known as Relapse, which is the regression from the Action or Maintenance SOC to an earlier SOC; Velicer et al., 1998). Indeed, the TTM views change as a temporal dimension and process, and research on helmet-related relapse would further the understanding of how people move through the stages over time with regard to helmet use behaviors.

This research was limited by the reliance on self-report data. Research has demonstrated that self-report helmet use rates are greater than observed rates (Ni, Tabachnick, Curtis, Cieslak, & Hedberg, 1997); therefore, participants in this research may have over-reported their actual rate of helmet use. While a focus on behavioral validation is recommended when using measures that rely on self-report for SOC placement (e.g., Hammond & Hall, 2015; Hellsten et al., 2008), notable limitations permitted behavioral validation of helmet use by participants who completed the questionnaire. Future research should continue to examine the reliability and validity of application of the TTM measures to helmet use behaviors.

The sample was skewed toward the Precontemplation SOC (53.9%). This is likely related to the demographics, as college-aged individuals have consistently low rates of helmet use. Uneven stage distribution is observed in the application of the TTM to other health behaviors (e.g., Weis et al., 2004, Prochaska et al., 2005). Uneven sample sizes can affect the homogeneity of variance assumption for the ANOVA test; thus, when this assumption was not met in the current research, statistical controls (alternate F tests and post-hoc analyses) were used accordingly. To address this limitation in future research, data from previous research could be aggregated to maximize numbers in all stages, or random sampling from the larger groups could be conducted to create equal SOC groups.

The emphasis of this research was on the individual level of behavioral change. Human behavior is also impacted at the community level, by organizations and societal influences such as socioeconomic status (Glanz & Rimer, 1995). As such, behavioral theories can be applied at both the individual and community level to address injury-related behaviors (Gielen & Sleet, 2003). Therefore, the application of behavioral theories to promote bicycle helmet use should not be limited to the individual level, and future research should continue to explore application of behavioral health theories at the community level to increase bicycle helmet use. One important area of intervention is legislation for bicycle helmet usage. Research in this area is important to promote nationwide helmet laws, as laws that mandate helmet use reinforce educational campaigns by supporting individuals to act on their knowledge (Rosenberg & Sleet, 1995).

Factors not examined in this research have been proposed to impact bicycle helmet use behaviors and attitudes. These factors include expectations of peers and family (Page et al., 1996), community factors (Kakefuda, Henry, & Stallones, 2009), and past bicycle helmet use (Cody, Quraishi, & Mickalide, 2004; Kakefuda et al., 2009). Research should investigate how these factors may impact helmet use behaviors of college-aged individuals.

Finally, future research should apply the findings of the current study to an intervention. The control group receives a standard helmet intervention based on the ThinkFirst model (treatment as usual); the experimental group receives a modified version of the same intervention based on the intervention techniques proposed in the current study. Pre and post measures of helmet use behaviors and views of helmet use should be analyzed to better understand the value of helmet interventions based on the TTM model. Future research should also investigate the efficacy of MI techniques (reflective listening, rolling with resistance, agenda setting and asking permission, eliciting change talk) when applied to helmet-based interventions.

Conclusion

Interventions to change health behaviors must be theory-driven, and the inclination to base interventions on ‘common sense’ instead of theory should be left in the past (Rutter &

Quine, 2002). While cycling represents the largest category of sports-related head injuries (AANS, 2011), minimal research exists to support successful application of a theory-based intervention for bicycle helmet use. Therefore, it is imperative that current research focuses on the application of a theory-based intervention to better understand helmet behavior change. In addition, this research should be used to improve current helmet promotion efforts.

The results of this study support the application of one such behavioral change theory, Prochaska and DiClemente's Transtheoretical Model of behavior change (TTM), to conceptualize and assess helmet interventions. This innovative study incorporated a multidimensional model to apply all constructs of the TTM (SOC, Decisional Balance, Self-Efficacy, and Processes of Change) to better understand bicycle helmet use behavior change. By addressing concerns that TTM research is limited by only applying some of the constructs, this is the first study to establish each of the TTM constructs with regard to helmet use.

Overall, the relationships among the constructs of the TTM and helmet use were similar to those found when the TTM is applied to other health-related behaviors (e.g., Nigg & Courney, 1998, Prochaska et al., 1994, Prochaska et al., 2005, Velicer et al., 1998). This study provides important information about factors that may impact helmet use behaviors. These factors include the use of cognitive and behavioral processes to successfully implement helmet-related behavior change, feelings of confidence to wear a helmet and temptation to not wear a helmet (and situations that may impact these factors), and the weighing of the costs and benefits of helmet use. In a novel contribution to this area of study, this research helped delineate differences in these factors between stages of helmet use behavior change.

These findings provide meaningful information to modify and improve current helmet promotion interventions based on the TTM of behavior change. Intervention techniques based on participant SOC were proposed accordingly. This research also adds to the scientific literature by providing baseline numbers for future research to assess change in college-aged helmet use over time. Furthermore, associations between helmet use and demographic and bicycle riding behavior factors (older age, longer bike riding distance, commuting, and history of a bike accident that required medical attention) were identified.

References

Adams, J., & White, M. (2005). Why don't stage-based activity promotion interventions work? *Health Education Research, 20*(2), 237-243. doi:10.1093/her/cyg105

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211. doi: 10.1016/0749-5978(91)90020-T

American Association of Neurological Surgeons. (2011, December). Sports-related head injury. Retrieved from http://www.aans.org

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavior change. *Psychology Review*, *84*, 191-215.

Bernier, M., & Avard, J. (1986). Self-efficacy, outcome, and attrition in a weight-reduction program. *Cognitive Therapy and Research*, *10*(3), 319-338.

Bolen, J. R., Kresnow, M. J., & Sacks, J. J. (1998). Reported bicycle helmet use among adults in the United States. *Archives of Family Medicine*, *7*(1), 72.

Bridle, C., Riemsma, R. P., Pattenden, J., Sowden, A. J., Mather, L., Watt, I. S., & Walker, A. (2005). Systematic review of the effectiveness of health behavior interventions based on the Transtheoretical model. *Psychology & Health, 20*(3), 283-301. doi:10.1080/08870440512331333997

Calderwood, K. A. (2011). Adapting the Transtheoretical model of change to the bereavement process. *Social Work, 56*(2), 107-118.

Centers for Disease Control and Prevention: The National Center for Injury Prevention and Control. (2009). Home and Recreational Safety: Bicycle Related Injuries. Atlanta, GA.

Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. (2017, April). Web-based Injury Statistics Query and Reporting System (WISQARS). Retrieved from http://www.cdc.gov/injury/wisqars

Channon, S., Smith, V. J., & Gregory, J. W. (2003). A pilot study of motivational interviewing in adolescents with diabetes. *Archives of disease in childhood*, *88*(8), 680-683.

Cody, B. E., Quraishi, A. Y., & Mickalide, A. D. (2004). Headed for injury: An observational survey of helmet use among children ages 5 to 14 participating in wheeled sports. *Washington, DC: National Safe Kids Campaign*.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, XX*(1), 37-46. doi:10.1177/001316446002000104

Conner, M., & Norman, P. (1995). Predicting Health Behaviour: Research and Practice with Social Cognition Models. Buckingham: Open University Press.

Coron, J., McLaughlin, G., & Dorman, S. M. (1996). Factors influencing use of bicycle helmets among undergraduate students. *Journal of American College Health, 44*(6), 294-297. doi:10.1080/07448481.1996.9936858

Dahl, S., Eagle, L., & Ebrahimjee, M. (2013). Golden moves: Developing a transtheoretical model-based social marketing intervention in an elderly population. *Social Marketing Quarterly*, *19*(4), 230-241.

De Vaus, D. (2002). *Surveys in social research* (5^{th} ed.). Sydney, Australia: Allen & Unwin.

DiClemente, C. C. (1981). Self-efficacy and smoking cessation maintenance: A preliminary report. *Cognitive Therapy and Research*, *5*(2), 175-187.

DiClemente, C.C. (1991). Motivational interviewing and the stages of change. In W. R. Miller & S. Rollnick (Eds.), *Motivational interviewing: Preparing people to change addictive behavior* (191–202). New York, MY: Guilford Press.

DiClemente, C. C., Prochaska, J. O., Fairhurst, S., Velicer, W. F., Rossi J. S., & Velasquez, M. (1991). The process of smoking cessation: An analysis of Precontemplation,

Contemplation, and Preparation stages of change. *Journal of Consulting and Clinical Psychology, 59*(2), 295-304. doi:10.1037/0022-006X.59.2.295

DiClemente, C. C., Prochaska, J. O., & Gibertini, M. (1985). Self-efficacy and the stages of self-change of smoking. *Cognitive Therapy and Research*, *9*(2), 181-200.

Donovan, R. J., Jones, S., Holman, C. D., & Corti, B. (1998). Assessing the reliability of a stage of change scale. *Health Education Research*, *13*(2), 285-291. doi:10.1093/her/13.2.285

Erol, S., & Erdogan, S. (2008). Application of a stage based motivational interviewing approach to adolescent smoking cessation: the Transtheoretical Model-based study. *Patient Education and Counseling*, *72*(1), 42-48.

Everett, S. A., Price, J. H., Bergin, D. A., & Groves, B. W. (1996). Personal goals as motivators: Predicting bicycle helmet use in university students. *Journal of Safety Research, 27*(1), 43-53. doi:10.1016/0022-4375(95)00025-9

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*, 1149-1160.

Finkelstein, E. A., Corso, P. S., & Miller, T. R. (2006). *The incidence and economic burden of injuries in the United States.* New York, NY: Oxford University Press.

Fishbein M., & Azjen I. (1975). Belief, attitude, intention, and behavior: an introduction to theory and research. Reading, MA: Addison-Wesley Publishing Co.

Fullerton, L., & Becker, T. (1991). Moving targets: Bicycle-related injuries and helmet use among university students. *Journal of American College Health, 39*(5), 213-217. doi:10.1080/07448481.1991.9936237

Gielen, A. C., & Sleet, D. (2003). Application of behavior-change theories and methods to injury prevention. *Epidemiologic Reviews, 25*, 65-76.

Glanz, K., & Rimer, B. K. (1995). *Theory at a glance: A guide for health promotion practice* (NIH Publication no. 95-3896). Bethesda, MD: U.S. Dept. of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute.

Gross, P. A., & Bonwich, M. (1982). Operationalizing the health belief model in a spinal cord injury prevention program. *Health Education, 13*(5), 27-27.

Hammond, J., & Hall, S. (2015, February). *Using the Transtheoretical Model of Behavior Change to Increase Bicycle Helmet Use.* Poster presented at the annual convention of the International Neuropsychological Society, Seattle, WA.

Harrison, J. A., Mullen, P. D., & Green, L. W. (1992). A meta-analysis of studies of the Health Belief Model with adults. *Health Education Research, 7*(1)*,* 107-116. doi:10.1093/her/7.1.107

The health belief model. (2007). In *Cambridge Handbook of Psychology, Health and Medicine.* Retrieved from http://www.credoreference.com/entry/cupphm/the_health_belief_model1

Hellsten, L., Nigg, C., Norman, G., Burbank, P., Braun, L., Breger, R., & Wang, T. (2008). Accumulation of behavioral validation evidence for physical activity stage of change. *Health Psychology,27*(1S), S43-S53. doi:10.1037/0278-6133.27.1(Suppl.). S43

Hoeppner, B. B., Velicer, W. F., Redding, C. A., Rossi, J. S., Prochaska, J. O., Pallonen, U. E., & Meier, K. S. (2006). Psychometric evaluation of the smoking cessation Processes of Change scale in an adolescent sample. *Addictive Behaviors, 31*(8), 1363-1372. doi:10.1016/j.addbeh.2005.11.002

Huang, S. J., Hung, W. C., Chang, M., & Chang, J. (2009). The effect of an internet-based, stage-matched message intervention on young Taiwanese women's physical activity. *Journal of health communication*, *14*(3), 210-227. doi:10.1080/10810730902805788

Hutchison, A. J., Breckon, J. D., & Johnston, L. H. (2009). Physical activity behavior change interventions based on the Transtheoretical model: A systematic review. *Health Education & Behavior, 36*(5), 829-845. doi:10.1177/1090198108318491

Jackson, R., Asimakopoulou, K., & Scammell, A. (2007). Assessment of the Transtheoretical model as used by dietitians in promoting physical activity in people with type 2 diabetes. *Journal of human nutrition and dietetics*, *20*(1), 27-36. doi:10.1111/j.1365-277X.2007.00746.x

Jewett, A., Beck, L. F., Taylor, C., & Baldwin, G. (2016). Bicycle helmet use among persons 5 years and older in the United States, 2012. *Journal of safety research*, *59*, 1-7. doi:10.1016/j.jsr.2016.09.001

Johnson, S. S., Paiva, A. L., Cummins, C. O., Johnson, J. L., Dyment, S. J., Wright, J. A., ... & Sherman, K. (2008). Transtheoretical model-based multiple behavior intervention for weight management: effectiveness on a population basis. *Preventive medicine*, *46*(3), 238-246.

Kakefuda, I. (2008). *Identifying factors associated with bicycle helmet use behavior among college students* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses. (3321285)

Kakefuda, I., Henry, K. L., & Stallones, L. (2009). Associations between childhood bicycle helmet use, current use, and family and community factors among college students. *Family & Community Health*, *32*(2), 159-166.

Kakefuda, I., Stallones, L., & Gibbs, J. (2008). Readiness for community-based bicycle helmet use programs: A study using community-and individual-level readiness models. *Journal of Health Psychology*, *13*(5), 639-643.

Lajunen, T., & Räsänen, M. (2004). Can social psychological models be used to promote bicycle helmet use among teenagers? A comparison of the health belief model, theory of planned behavior and the locus of control. *Journal of Safety Research, 35*(1), 115-123.

Langlois, J. A., Rutland-Brown, W., & Wald, M. M. (2006). The epidemiology and impact of traumatic brain injury: A brief overview. *The Journal of Head Trauma Rehabilitation, 21*(5), 375-378. doi:00001199-200609000-00001

Lichtenstein, E., & Glasgow, R. E. (1992). Smoking cessation: What have we learned over the past decade? *Journal of Consulting and Clinical Psychology, 60*(4), 518-527. doi:10.1037/0022-006X.60.4.518

Littell, J. H., & Girvin, H. (2002). Stages of change: A critique. *Behavior Modification, 26*(2), 223-273. doi:10.1177/0145445502026002006

Ludwig, T. D., Buchholz, C., & Clarke, S. W. (2005). Using social marketing to increase the use of helmets among bicyclists. *Journal of American College Health, 54*(1), 51-58.

Kassin, S., Fein, S., & Markus, H. R. (2010). *Social Psychology, Eighth Edition.* Belmont, CA: Wadsworth, Cengage Learning.

Maibach, E. W., & Cotton, D. (1995). Moving people to behavior change: A staged social cognitive approach to message design. In Maibach, E. W. and Parrott, R. L. (eds.), *Designing Health Messages: Approaches from Communication Theory and Public Health*. Sage, Thousand Oaks, CA, pp. 41–64.

Marcus, B. H., Selby, V. C., Niaura, R. S., & Rossi, J. S. (1992). Self-efficacy and the stages of exercise behavior change. *Research Quarterly in Exercise and Sport*, *63*, 60-66.

Marlatt, G. A., Baer, J. S., & Quigley, L. A. (1994). Self-efficacy and addictive behavior. In A. Bandura (Ed.), *Self-efficacy in changing societies*. Marbach, Germany: Johann Jacobs Foundation.

Marshall, S. J., & Biddle, S. J. (2001). The Transtheoretical model of behavior change: a meta-analysis of applications to physical activity and exercise. *Annals of Behavioral Medicine*, *23*(4), 229-246.

Mason, J. O., & Tolsma, D. D. (1984). Personal health promotion. *Western Journal of Medicine*, *141*(6), 772. National Highway Traffic Safety Administration. (2008, January). Bicycle helmet use laws (Report DOT HS 810886W). Retrieved from http://www.nrd.nhtsa.dot.gov/pubs /811156.pdf

National Highway Traffic Safety Administration. (2015). Traffic safety facts, 2013 data – bicyclists and other cyclists. Washington, DC: US Department of Transportation.

National Research Council. (1985). Injury in America: A continuing public health problem. Washington, DC: National Academy Press.

Ni, H., Sacks, J. J., Curtis, L., Cieslak, P. R., & Hedberg, K. (1997). Evaluation of a statewide bicycle helmet law via multiple measures of helmet use. *Archives of Pediatrics & Adolescent Medicine, 151*(1), 59-65.

Nigg, C. R., & Courney, K. S. (1998). Transtheoretical model: Examining adolescent exercise behavior. *Journal of Adolescent Health*, *22*(3), 214-224.

Nigg, C. R., Geller, K. S., Motl, R. W., Horwath, C. C., Wertin, K. K., & Dishman, R. K. (2011). A research agenda to examine the efficacy and relevance of the Transtheoretical model for physical activity behavior. *Psychology of sport and exercise*, *12*(1), 7-12.

Noar, S. M., Benac, C. N., and Harris, M. S. (2007). Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychological Bulletin, 4*, 673-693

Norcross, J. C., Krebs, P. M., & Prochaska, J. O. (2011). Stages of change. *Journal of Clinical Psychology, 67*, 143-154. doi: 10.1002/jclp.20758

Page, R., Follett, T., Scanlan, A., Hammermeister, J., & Friesen, R. (1996). Perceived barrier, risk perception, and social norm attitudes about wearing helmets among college students. *American Journal of Health Behavior, 20*(1), 33-40.

Patrick, K., Covin, J. R., Fulop, M., Calfas, K., & Lovato, C. (1997). Health risk behaviors among California college students. *Journal of American College Health, 45*(6), 265-272. doi:10.1080/07448481.1997.9936896

Pendergrast, R. A., Ashworth, C., DuRant, R. H., & Litaker, M. (1992). Correlates of children's bicycle helmet use and short-term failure of school-level interventions. *Pediatrics*, *90*(3), 354.

Petty, R. E., Cacioppo, J. T., & Schumann, D. (1983). Central and peripheral routes to advertising effectiveness: The moderating role of involvement. *Journal of consumer research*, *10*(2), 135-146.

Prat, F., Planes, M., Gras, M. E., & Sullman, M. J. M. (2012). Stages of change and decisional balance for condom use with a romantic partner. *Journal of Health Psychology, 17*(8), 1193-1202.

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change in smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology, 5*, 390-395. doi:10.1037/0022-006X.51.3.390

Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1992). In search of how people change: Applications to addictive behaviors. *American Psychologist, 47*(9), 1102-1114.

Prochaska, J. O., DiClemente, C. C., Velicer, W. F., Ginpil, S., & Norcross, J. C. (1985). Predicting change in smoking status for self-changers. *Addictive Behavior, 10*(4), 395-406. doi:10.1016/0306-4603(85)90036-X

Prochaska, J. O., & Marcus, B. H. (1994). The Transtheoretical model: Applications to exercise. In R. K. Dishman (Ed.), *Advances in Exercise Adherence* (pp. 161-180). Champaigne, IL.

Prochaska, J.O., Norcross, J.C., Fowler, J.L., Follick, M.J., & Abrams, D.B. (1992). Attendance and outcome in a work site weight control program: Processes and stages of change as process and predictor variables. *Addictive Behaviors, 17*, 35-45.

Prochaska, J. M., Paiva, A. L., Padula, J. A., Prochaska, J. O., Montgomery, J. E., Hageman, L., & Bergart, A. M. (2005). Assessing emotional readiness for adoption using the Transtheoretical model. *Children and Youth Services Review, 27*(2), 135-152. doi:10.1016/j.childyouth.2004.07.001

Prochaska, J. O., & Prochaska, J. M. (2011). Behavior change. In C. Heverling &T. Reilly (Eds.), *Population health: Creating a culture of wellness* (23-42). Sudbury, MA: Jones & Bartlett Learning, LLC.

Prochaska, J. O., Velicer, W. F., DiClemente, C. C., & Fava, J. L. (1988). Measuring the Processes of Change: Applications to the cessation of smoking. *Journal of Consulting and Clinical Psychology 56*, 520-528. doi:10.1037/0022-006X.56.4.520

Prochaska, J. O., Velicer, W. F., Rossi, J. S., Goldstein, M. G., Marcus, B. H., Rakowski, W., & Rossi, S. R. (1994). Stages of change and decisional balance for 12 Problem behaviors. *Health Psychology, 13*(1), 39-46. doi:10.1037/0278-6133.13.1.39

Quine, L., Rutter, D. R., & Arnold, L. (1998). Predicting and understanding safety helmet use among schoolboy cyclists: A comparison of the theory of planned behaviour and the health belief model. *Psychology & Health, 13*(2), 251-269. doi:10.1080/08870449808406750

Quine, L., Rutter, D. R., & Arnold, L. (2001). Persuading school-age cyclists to use safety helmets: Effectiveness of an intervention based on the theory of planned behaviour. *British Journal of Health Psychology, 6*(4), 327.

Quine, L., Rutter, D., & Arnold, L. (2002). Increasing cycle helmet use in school-age cyclists: an intervention based on the Theory of Planned Behaviour. In D. Rutter & L. Quine (Eds.), *Changing health behaviour* (pp. 172-192). Maidenhead: Open University Press.

Resnicow, K., DiIorio, C., Soet, J. E., Borrelli, B., Hecht, J., & Ernst, D. (2002). Motivational interviewing in health promotion: it sounds like something is changing. *Health Psychology*, *21*(5), 444.

Rosenberg, M. L., & Sleet, D. A. (1995). Injury control recommendations for bicycle helmets. *Journal of School Health, 65*, 133-139.

Rosenberg, R. I., Zirkle, D. L., & Neuwelt, E. A. (2005). Program self-evaluation: The evolution of an injury prevention foundation. *Journal of Neurosurgery*, *102*(5), 847-849.

Rosenstock, I. M. (1974). The Health Belief Model and preventive health behavior. *Health Education Monographs, 2*, 354-386.

Ross, T. P., Ross, L. T., Rahman, A., & Cataldo, S. (2010). The bicycle helmet attitudes scale: Using the health belief model to predict helmet use among undergraduates. *Journal of American College Health, 59*(1), 29-36. doi:10.1080/07448481.2010.483702

Royal, S., Kendrick, D., & Coleman, T. (2005). Non-legislative interventions for the promotion of cycle helmet wearing by children. *Cochrane Database of Systematic Reviews*, *2*. Art. No.: CD003985. doi: 10.1002/14651858.CD003985.pub2.

Royal, S., Kendrick, D., & Coleman, T. (2007). Promoting bicycle helmet wearing by children using non-legislative interventions: Systematic review and meta-analysis. *Injury Prevention*, *13*(3), 162-167.

Runyan, C. W., & Runyan, D. K. (1991). How can physicians get kids to wear bicycle helmets? A prototypic challenge in injury prevention. *American Journal of Public Health, 81*(8), 972-973. doi:10.2105/AJPH.81.8.972

Rutherford, G. W., & Corrigan, J. D. (2009). Long-term consequences of traumatic brain injury. *The Journal of Head Trauma Rehabilitation, 24*(6), 421-423. doi:10.1097/HTR.0b013e3181c13439

Rutter, D. R., & Quine, L. (2002). Social cognition models and changing health behaviors. In D. Rutter & L. Quine (Eds.), *Changing health behavior.* (pp. 1-27). *Maidenhead*: *Open University Press.*

Sacks, J. J., Holmgreen, P., Smith, S. M., & Sosin, D. M. (1991). Bicycle-associated head injuries and deaths in the United States from 1984 through 1988: How many are preventable? *Journal of the American Medical Association*, *266*(21), 3016–3018. doi:10.1001/jama.1991.03470210084038

Schulman, J., Sacks, J., & Provenzano, G. (2002). State level estimates of the incidence and economic burden of head injuries stemming from non-universal use of bicycle helmets. *Injury Prevention: Journal of the International Society for Child and Adolescent Injury Prevention, 8*(1), 47-52.

Thompson, D. C., Rivara, F. P., & Thompson, R. (1999). Helmets for preventing head and facial injuries in bicyclists. *Cochrane Database of Systematic Reviews*, *4*.

Thompson, N. J., Sleet, D., & Sacks, J. J. (2002). Increasing the use of bicycle helmets: lessons from behavioral science. *Patient education and counseling*, *46*(3), 191-197.

Thurman, D. J., Alverson, C., Dunn, K. A., Guerrero, J., & Sniezek, J. E. (1999). Traumatic brain injury in the United States: A public health perspective. *The Journal of Head Trauma Rehabilitation, 14*(6), 602-615.

Towner, P. & Marvel, M. K. (1992). A school-based intervention to increase the use of bicycle helmets. *Family Medicine, 24*(2), 156-158.

Trifiletti, L. B., Gielen, A. C., Sleet, D. A. & Hopkins, K. (2005). Behavioral and social sciences theories and models: Are they used in unintentional injury prevention research? *Health Education Research, 20*(3), 298-307. doi:10.1093/her/cyg126

van Leer, E., Hapner, E. R., & Connor, N. P. (2008). Transtheoretical model of health behavior change applied to voice therapy. *Journal of Voice, 22*(6), 688-698. doi:http://dx.doi.org.weblib.lib.umt.edu:8080/10.1016/j.jvoice.2007.01.011

Velicer, W. F., DiClemente, C. C., Rossi, J. S., & Prochaska, J. O. (1990). Relapse situations and self-efficacy: An integrative model. *Addictive Behaviors, 15*(3), 271-283. doi:10.1016/0306-4603(90)90070-E

Velicer, W. F, Prochaska, J. O., Fava, J. L., Norman, G. J., & Redding, C. A. (1998). Smoking cessation and stress management: Applications of the Transtheoretical model of behavior change. *Homeostasis in Health and Disease, 38*(5-6), 216-233.

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology, 39*(5), 806-820. doi:10.1037/0022-3514.39.5.806

Weiss, B. D. (1996). Helmet use among university bicyclists. *Journal of American College Health, 44*(6), 298.

Weiss, J., Okun, M., & Quay, N. (2004). Predicting bicycle helmet stage-of-change among middle school, high school, and college cyclists from demographic, cognitive, and motivational variable. *The Journal of Pediatrics, 145*(3), 360-364. doi:10.1016/j.jpeds.2004.05.034

Whelan-Goodinson, R., Ponsford, J., Johnston, L., & Grant, F. (2009). Psychiatric disorders following traumatic brain injury: Their nature and frequency. *The Journal of Head Trauma Rehabilitation, 24*(5), 324-332. doi:10.1097/HTR.0b013e3181a712aa

Will, K. E. (2005). Child passenger safety and the immunity fallacy: Why what we are doing is not working. *Accident Analysis and Prevention, 37*(5), 947-955.

Wright, M., Rivara, F. P., & Ferse, D. (1995). Evaluation of the Think First head and spinal cord injury prevention program. *Injury Prevention, 1*(2), 81-85. doi:10.1136/ip.1.2.81

Appendix A
Demographic Information
Bicycle Riding Behaviors

Age: ______ **Gender:** __________ **Ethnicity:** ________________________

What is the highest grade you have completed? (Please report years **completed.** For example, if you are a freshman you are in your 13th year of school, but you have completed 12 years of education. So, you would indicate 12) _______

Please circle the best response to the questions below:

How often do you ride a bike when the weather permits?
5-7 times/week 3-4 times/week 1-2 times/week 1-2 times/month 1-2 times/year NEVER

How far do you usually ride a bike? > 5 miles/week 1-5 miles/week <1 mile/week NEVER

Why do you ride a bike? for pleasure to commute to work/school both for pleasure & to commute

Where do you usually ride a bike? in a rural area in an urban area both

Have you ever been in a bike accident that required any level of medical treatment? YES NO

Appendix B
Stages of Change

Do you Consistently wear a helmet when you ride a bicycle? (Please choose the most accurate response)

Yes, I have been for MORE than 6 months.
Yes, I have been for LESS than 6 months.
No, but I intend to in the next 30 days.
No, but I intend to in the next 6 months.
No, and I do NOT intend to in the next 6 months.

Appendix C

Decision Balance (Pros and Cons)

Please indicate the relative importance to each statement below using the following 5 point scale:

1 = Very unimportant
2 = Somewhat unimportant
3 = Neither important nor unimportant
4 = Somewhat important
5 = Very important

(1) Wearing a helmet is a good choice. _________
(2) Smart riders wear helmets. _________
(3) Helmets decrease head injuries. _________
(4) Helmets help protect me while sharing the road with cars. _________
*(5) I feel safer when I wear a helmet while riding a bike.*___________
(6) People tease people who wear helmets. _________
(7) Wearing a helmet makes it less fun to ride a bike. _________
(8) Wearing a helmet is uncomfortable. _________
(9) Wearing a helmet will mess up my hair. _________
(10) Helmets cost more than I am willing to pay. ___________

Appendix D

Self-efficacy (Confidence and Temptation)

Listed below are situations that result in some people not wearing a bicycle helmet. **Please enter the numbers in the boxes that best corresponds to your present feelings of TEMPTATION and CONFIDENCE in each situation using the following 5 point scale.**

1 = Not at all
2 = Not very
3 = Moderately
4 = Very
5 = Extremely

Confidence to wear a helmet (1 – 5)	**Situation**	**Temptation to not wear a helmet (1 - 5)**
	Positive Affect Situations	
____________	When I am feeling really good.	____________
____________	When things are going really well for me.	____________
____________	When I feel like having a good time.	____________
____________	When I am really happy.	____________
	Negative Affect Situations	
____________	When I am feeling angry or depressed.	____________
____________	When I am worried about something.	____________
____________	When I am stressed.	____________
____________	When I am nervous.	____________
	Habit Situations	
____________	When I think my helmet use behaviors are not a problem.	____________
____________	When I have a strong urge to not wear a helmet.	____________
____________	When I think it is okay to not wear a helmet just one time.	____________
____________	When I am in a situation that I have not worn a helmet in the past.	____________
____________	When I realize that I have been wearing a helmet a lot lately.	____________
____________	When I am in a situation that I have worn a helmet in the past	____________
____________	When I become overconfident about my bicycle riding abilities.	____________

Environmental Cues (Context)

________	When my helmet is easy to access.	________
________	When I only have to ride a short distance.	________
________	When the weather is clear with no precipitation.	________
________	When the weather is rainy or snowy.	________
________	When I am exposed to information about helmet use or brain injury prevention	________
________	When I am recreational biking with friends.	________
________	When I am commuting to work and/or school.	________
________	When I am in a rush.	________
________	When the helmet will mess up my hair.	________

Social Cues (Social Situations)

________	When other people encourage me to <u>not</u> wear a helmet.	________
________	When I am with friends who are <u>not</u> wearing a helmet.	________
________	When I see others wearing a helmet.	________
________	When other people encourage me to wear a helmet.	________
________	When I am with friends who are wearing a helmet.	________
________	When I see others <u>not</u> wearing a helmet.	________

Appendix E
Processes of Change

The following experiences can affect the bicycle helmet-usage behaviors of some people. Think of any similar experiences you may be currently having or have had in the last month. **Then rate how frequently the event occurs by circling the appropriate number.** Please rate using the following 5-point scale.

1 = Never
2 = Seldom
3 = Occasionally
4 = Often
5 = Repeatedly

1. I am aware of more and more people who are regularly wearing a bicycle helmet. ____
2. I feel ashamed or disappointed in myself when I do NOT wear a bicycle helmet. ____
3. I react emotionally to warnings about the health hazards of NOT wearing a bicycle helmet. ____
4. I feel better about myself when I wear a bicycle helmet. ____
5. Information from the media (online sources, magazines, newspaper, T.V.) about bicycle helmet use seems to catch my eye. ____
6. I have friends who encourage me to wear a bicycle helmet, even if I do not feel like it. ____
7. I consider the view that my bicycle helmet use behaviors serve as a model to others. ____
8. I am afraid of the consequences to my health if I do NOT wear a bicycle helmet. ____
9. When I am tempted to NOT wear a bicycle helmet, I try to remind myself of the benefits of wearing a helmet. ____
10. I avoid situations in which I will have to ride a bike without a helmet. ____
11. I recall information people have given me on the benefits of wearing a bicycle helmet. ____
12. I think that regular bicycle helmet use plays a role in reducing health care costs by reducing the risk of brain injury. ____
13. I get upset when I see people who would benefit from wearing a bicycle helmet NOT wearing a helmet. ___
14. I reward myself when I wear a bicycle helmet. ____
15. I have someone who tries to share his or her personal experiences of helmet use with me. ____
16. Instead of wearing a hat or nothing on my head when I ride a bicycle, I wear a helmet. ____
17. I have found that many people know that wearing a bicycle helmet is good for them. ____
18. I stop and think about the impact I may have on the people I care about if I sustain a brain injury while riding a bicycle because I was NOT wearing a helmet. ____
19. I make sure that I always have access to a bicycle helmet when I plan to ride a bike. ____

20. I tell myself that if I try hard enough, I can regularly wear a bicycle helmet when I ride a bike. ____
21. I find society changing in ways that makes it easier to wear a bicycle helmet. ____
22. I make commitments to myself to wear a bicycle helmet. ____
23. I have heard that bicycle helmet use reduces the risk of brain injury. ____
24. If I engage in regular helmet use, I find that I feel safer. ____
25. I believe that regular bicycle helmet use will make me a healthier person. ____
26. I keep a bicycle helmet conveniently located to remind me to wear a helmet. ____
27. Someone in my life makes me feel good when I wear a bicycle helmet. ____
28. I believe that I can wear a bicycle helmet regularly. ____
29. I am rewarded by others if I wear a bicycle helmet. ____
30. Even if I can't easily find my bicycle helmet, I make myself find it anyways before I ride because I know I will feel safer with a helmet on. ____

Consciousness Raising (11, 5, 23)
Dramatic Relief (3, 13, 8)
Environmental Reevaluation (7, 12, 18)
Self Reevaluation (2, 4, 25)
Social Liberation (21, 17, 1)
Counterconditioning (16, 30, 9)
Helping Relationships (29, 6, 15)
Self Liberation (22, 28, 20)
Stimulus Control (26, 19, 10)
Reinforcement Management (14, 24, 27)

Appendix F

SUBJECT INFORMATION AND CONSENT FORM – UNIVERSITY OF MONTANA

TITLE
Application of the Transtheoretical Model of Behavior Change to Bicycle Helmet Use Behaviors

INVESTIGATORS
Julia Hammond, Dept. of Psychology, The University of Montana, Missoula, MT 59812, 243-5667
Dr. Stuart Hall, Faculty Supervisor, Dept. of Psychology, The University of Montana, Missoula, MT 59812, 243-5667

Special Instructions to the potential subject
Thank you for considering participation in this study. This consent form may contain words that are unfamiliar to you. If the contents of this form are unclear, please ask the person who gave you this form to explain it to you.

Purpose
You are being asked to take part in a research investigation of helmet use attitudes and behaviors. The purpose of this research study is to better understand helmet use in college-aged individuals. By signing below, you are giving your voluntary consent to participate in this research study.

Procedures
It will take about 10 minutes to complete this survey. Please answer all questions to the best of your ability. After you have completed the survey, please give the survey and the informed consent to the research assistant.

This consent form will be filed and locked separately from all testing and questionnaires that you complete.

Risks/Discomforts
As a participant, it is expected that the amount of discomfort you experience will be minimal.

Payment for Participation
You will receive two research credit points for Psychology 100 for completing this survey.

Benefits
This experience may provide you with exposure to scientific research in psychology. Your participation will also provide very beneficial information to professionals working in the field of psychology, and will help them to better understand helmet use behaviors.

Confidentiality
<u>The information you provide will be held strictly confidential by the research examiners.</u> To participate, you will need to sign this informed consent form, which will be kept locked up and separate from all testing and questionnaire materials. This signed consent form will be kept in a secure, locked file drawer for three years after the completion of the study, per federal regulation.

Compensation for Injury
Although there is minimal risk associated with your participation in this study, The University of Montana requires that the following paragraph be included in all consent forms.

"In the event that you are injured as a result of this research you should individually seek appropriate medical treatment. If the injury is caused by the negligence of the University or any of its employees, you may be entitled to reimbursement or compensation pursuant to the Comprehensive State Insurance Plan established by the Department of Administration under the authority of M.C.A., Title 2, Chapter 9. In the event of a claim for such injury, further information may be obtained from the University's Claims representative or University Legal Counsel. (Reviewed by University Legal Counsel, July 6, 1993)."

Voluntary Participation/Withdrawal
Your participation in this study is entirely voluntary, and you may withdraw without penalty or any negative consequences. If you choose to withdraw, all your records will be destroyed, and the data you provided will not be used in this study. If you decide to withdraw from this experiment, you will still receive your experimental credits.

Questions
If you have questions about this study while completing the questionnaire, please ask the examiner. Additionally, you may contact the principal investigator (Julia Hammond, 243-5667) or Stuart Hall, Ph.D. (243-5667) if you have any further questions about the study. If you have any questions regarding your rights as a research participant, you may contact the UM Institutional Chair at 243-6670.

Subject's Statement of Consent
I have read the above description of this study and have been informed of the benefits and risks involved. All of my questions have been answered to my satisfaction, and I have been provided with the contact information for the principal investigator and the faculty supervisor in the event that I have concerns or questions in the future. By signing below I voluntarily agree to participate in this study and give my consent to the examiners to use the information I provide for the purposes of this experiment.

____
Printed Name of Participant

______________________________ ____________________
Participant's Signature Date

______________________________ ____________________
Examiner's Signature Date

Appendix G

Mean Differences and Effect Sizes: Post Hoc Comparisons for all Six Dependent Variables

SOC	Construct	Mean (SD)	PC	C	P	A	M
PC	PRO	4.11 (.78)					
	CON	2.80 (.94)					
	Confidence	2.38 (.96)					
	Temptation	3.26(1.11)					
	Experiential	2.24 (.69)					
	Behavioral	1.52 (.58)					
C	PRO	4.42 (.66)	-.31* (.43)				
	CON	2.50 (.90)	.30				
	Confidence	3.16 (.83)	-.78 (.87)				
	Temptation	2.80 (.80)	.46* (.48)				
	Experiential	3.05 (.75)	-.81* (1.12)				
	Behavioral	2.32 (.79)	-.81*(1.15)				
P	PRO	4.64 (.33)	-.53* (.88)	-.22			
	CON	2.36 (.79)	.44	.14			
	Confidence	2.97 (.77)	-.60* (.68)	.18			
	Temptation	2.89 (.92)	.37	-.09			
	Experiential	2.95 (.66)	-.71* (1.05)	.10			
	Behavioral	2.33 (.73)	-.81* (1.23)	-.01			
A	PRO	4.74 (.39)	-.63* (1.02)	-.32	-.099		
	CON	2.01 (.94)	.79* (.84)	.49	.35		
	Confidence	3.88 (.84)	-1.50* (1.66)	-.72* (.86)	-.91* (1.13)		
	Temptation	2.09 (.93)	1.17*(1.14)	.71	.80		
	Experiential	3.36 (.75)	-1.13* (1.55)	-.32	-.41		
	Behavioral	3.07 (.86)	-1.56* (2.11)	-.75* (.91)	-.74* (.93)		
M	PRO	4.69 (.60)	-.59* (.83)	-.28* (.43)	-.053	.046	
	CON	2.11 (.81)	.69* (.79)	.39* (.46)	.25	-.10	
	Confidence	3.97 (.85)	-1.59* (1.75)	-.81* (.96)	-.99* (1.23)	-.09	
	Temptation	2.02 (.90)	1.24*(1.23)	.78* (.92)	.87* (.96)	.07	
	Experiential	3.49 (.75)	-1.25* (1.73)	-.44* (.59)	-.53* (.76)	-.12	
	Behavioral	3.27 (.81)	-1.76* (2.48)	-.95* (1.19)	-.94* (1.22)	-.20	

Note. PC = Precontemplation, C = Contemplation, P = Preparation, A = Action, M= Maintenance.

Appendix H

Mean Scores on Each Confidence Item of the Self-Efficacy Construct (Ranked Order)

	Confidence Score		
Self-Efficacy Questionnaire Item	*N*	Mean	SD
When I am exposed to information about helmet use or brain injury prevention. (Context)	529	3.84	1.39
When my helmet is easy to access (Context)	535	3.68	1.41
When other people encourage me to wear a helmet (Social Situations)	532	3.68	1.39
When I am with friends who are wearing a helmet (Social Situations)	532	3.61	1.45
When the weather is rainy or snowy (Context)	531	3.58	1.47
When I see others wearing a helmet (Social Situations)	533	3.44	1.44
When I am in a situation that I have worn a helmet in the past (Habit Situation)	529	3.38	1.52
When I realize that I have been wearing a helmet a lot lately (Habit Situation)	528	3.22	1.51
When things are going really well for me (Positive Affect Situations)	533	3.12	1.45
When I am feeling really good (Positive Affect Situations)	533	3.11	1.46
When I am feeling really happy (Positive Affect Situations)	533	3.05	1.46
When I am nervous (Negative Affect Situations)	532	2.97	1.53
When I am commuting to work and/or school (Context)	530	2.96	1.53
When I feel like having a good time (Positive Affects Situations)	533	2.95	1.48
When I am worried about something (Negative Affect Situations)	530	2.85	1.47
When I think my helmet use behaviors are not a problem (Habit Situation)	528	2.85	1.53
When I am recreational biking with friends (Context)	529	2.82	1.57
When I am stressed (Negative Affect Situations)	531	2.74	1.44
When I see others not wearing a helmet (Social Situations)	526	2.71	1.48
When I become overconfident about my bicycle riding abilities (Habit Situation)	517	2.67	1.50
When other people encourage me to not wear a helmet (Social Situations)	527	2.67	1.50
When I am in a situation that I have not worn a helmet in the past (Habit Situation)	523	2.65	1.57
When the weather is clear with no precipitation (Context)	530	2.58	1.55
When I am feeling angry or depressed (Negative Affect Situations)	530	2.57	1.45
When the helmet will mess up my hair (Context)	527	2.51	1.53
When I think it is okay to not wear a helmet just one time (Habit Situation)	525	2.46	1.46
When I am with friends who are not wearing a helmet (Social Situations)	526	2.42	1.47
When I am in a rush (Context)	527	2.40	1.49
When I have a strong urge to not wear a helmet (Habit Situation)	525	2.37	1.49
When I only have to ride a short distance (Context)	527	2.24	1.46

Appendix I

Mean Scores on Each Temptation Item of the Self-Efficacy Construct (Ranked Order)

	Temptation Score		
Self-Efficacy Questionnaire Item	*N*	Mean	SD
When I think it is okay to not wear a helmet just one time (Habit Situation)	528	3.54	1.52
When I only have to ride a short distance (Context)	531	3.54	1.60
When I have a strong urge to not wear a helmet (Habit Situation)	529	3.52	1.59
When I am in a situation that I have not worn a helmet in the past (Habit Situation)	526	3.35	1.58
When I am with friends who are not wearing a helmet (Social Situations)	533	3.23	1.56
When I am in a rush (Context)	530	3.22	1.58
When I become overconfident about my bicycle riding abilities (Habit Situation)	524	3.20	1.61
When the weather is clear with no precipitation (Context)	525	3.17	1.62
When I think my helmet use behaviors are not a problem (Habit Situation)	524	3.15	1.63
When I feel like having a good time (Positive Affects Situations)	529	3.02	1.54
When I am feeling really good (Positive Affect Situations)	529	3.01	1.56
When other people encourage me to not wear a helmet (Social Situations)	530	3.01	1.58
When I see others not wearing a helmet (Social Situations)	533	3.00	1.51
When I am recreational biking with friends (Context)	526	2.99	1.58
When things are going really well for me (Positive Affect Situations)	530	2.96	1.52
When I am feeling really happy (Positive Affect Situations)	529	2.96	1.54
When I am feeling angry or depressed (Negative Affect Situations)	532	2.93	1.52
When the helmet will mess up my hair (Context)	525	2.90	1.60
When I am stressed (Negative Affect Situations)	530	2.78	1.51
When I am commuting to work and/or school (Context)	525	2.77	1.55
When I am worried about something (Negative Affect Situations)	531	2.75	1.49
When I am nervous (Negative Affect Situations)	529	2.63	1.52
When I realize that I have been wearing a helmet a lot lately (Habit Situation)	524	2.54	1.50
When I am in a situation that I have worn a helmet in the past (Habit Situation)	523	2.47	1.45
When I see others wearing a helmet (Social Situations)	526	2.34	1.37
When my helmet is easy to access (Context)	523	2.3	1.40
When the weather is rainy or snowy (Context)	519	2.29	1.42
When other people encourage me to wear a helmet (Social Situations)	526	2.22	1.33
When I am with friends who are wearing a helmet (Social Situations)	526	2.21	1.38
When I am exposed to information about helmet use or brain injury prevention. (Context)	518	2.13	1.37

Appendix J

Mean Scores on Self-Efficacy Construct Items (Grouped by Situation and Confidence Score Ranked Order)

	Confidence			Temptation		
Self-Efficacy Questionnaire Item	*N*	Mean	SD	N	Mean	SD
Positive Affect Situations						
When things are going really well for me.	533	3.12	1.45	530	2.96	1.52
When I am feeling really good.	533	3.11	1.46	529	3.01	1.56
When I am feeling really happy.	533	3.05	1.46	529	2.96	1.54
When I feel like having a good time.	533	2.95	1.48	529	3.02	1.54
Negative Affect Situations						
When I am nervous.	532	2.97	1.53	529	2.63	1.52
When I am worried about something.	530	2.85	1.47	531	2.75	1.49
When I am stressed.	531	2.74	1.44	530	2.78	1.51
When I am feeling angry or depressed.	530	2.57	1.45	532	2.93	1.52
Habit Situations						
When I am in a situation that I have worn a helmet in the past	529	3.38	1.52	523	2.47	1.45
When I realize that I have been wearing a helmet a lot lately.	528	3.22	1.51	524	2.54	1.50
When I think my helmet use behaviors are not a problem.	528	2.85	1.53	524	3.15	1.63
When I become overconfident about my bicycle riding abilities.	517	2.67	1.50	524	3.20	1.61
When I am in a situation that I have not worn a helmet in the past.	523	2.65	1.57	526	3.35	1.58
When I think it is okay to not wear a helmet just one time.	525	2.46	1.46	528	3.54	1.52
When I have a strong urge to not wear a helmet.	525	2.37	1.49	529	3.52	1.59
Environmental Cues (Context)						
When I am exposed to information about helmet use or brain injury prevention	529	3.84	1.39	518	2.13	1.37
When my helmet is easy to access.	535	3.68	1.41	523	2.30	1.40
When the weather is rainy or snowy.	531	3.58	1.47	519	2.29	1.42
When I am commuting to work and/or school.	530	2.96	1.53	525	2.77	1.55
When I am recreational biking with friends.	529	2.82	1.57	526	2.99	1.58
When the weather is clear with no precipitation.	530	2.58	1.55	525	3.17	1.62
When the helmet will mess up my hair.	527	2.51	1.53	525	2.90	1.60
When I am in a rush.	527	2.40	1.49	530	3.22	1.58
When I only have to ride a short distance.	527	2.24	1.46	531	3.54	1.60
Social Cues (Social Situations)						
When other people encourage me to wear a helmet.	532	3.68	1.39	526	2.22	1.33
When I am with friends who are wearing a helmet.	532	3.61	1.45	526	2.21	1.38
When I see others wearing a helmet.	533	3.44	1.44	526	2.34	1.37
When I see others not wearing a helmet.	526	2.71	1.48	533	3.00	1.51
When other people encourage me to not wear a helmet.	527	2.67	1.50	530	3.01	1.58
When I am with friends who are not wearing a helmet.	526	2.42	1.47	533	3.23	1.56

Appendix K

Mean Scores on Each Item of the Processes of Change Questionnaire (Ranked Order)

Questionnaire Item	*N*	Mean	SD
I have heard that bicycle helmet use reduces the risk of brain injury.	541	4.10	1.20
I think that regular bicycle helmet use plays a role in reducing health care costs by reducing the risk of brain injury.	539	3.47	1.34
I have found that many people know that wearing a bicycle helmet is good for them.	543	3.38	1.35
If I engage in regular helmet use, I find that I feel safer.	540	2.91	1.49
I believe that I can wear a bicycle helmet regularly.	542	2.85	1.50
I am aware of more and more people who are regularly wearing a bicycle helmet.	545	2.84	1.19
I am afraid of the consequences to my health if I do NOT wear a bicycle helmet.	542	2.82	1.41
I recall information people have given me on the benefits of wearing a bicycle helmet.	543	2.78	1.33
I feel better about myself when I wear a bicycle helmet. .	542	2.75	1.39
I believe that regular bicycle helmet use will make me a healthier person.	538	2.71	1.48
When I am tempted to NOT wear a bicycle helmet, I try to remind myself of the benefits of wearing a helmet.	543	2.52	1.41
I find society changing in ways that makes it easier to wear a bicycle helmet.	539	2.52	1.30
I stop and think about the impact I may have on the people I care about if I sustain a brain injury while riding a bicycle because I was NOT wearing a helmet.	541	2.44	1.36
I consider the view that my bicycle helmet use behaviors serve as a model to others.	544	2.33	1.34
I get upset when I see people who would benefit from wearing a bicycle helmet NOT wearing a helmet.	539	2.33	1.36
I react emotionally to warnings about the health hazards of NOT wearing a bicycle helmet.	541	2.27	1.24
I make sure that I always have access to a bicycle helmet when I plan to ride a bike.	543	2.25	1.43
Instead of wearing a hat or nothing on my head when I ride a bicycle, I wear a helmet.	542	2.24	1.45
I tell myself that if I try hard enough, I can regularly wear a bicycle helmet when I ride a bike.	542	2.23	1.37
I feel ashamed or disappointed in myself when I do NOT wear a bicycle helmet.	545	2.15	1.28
I avoid situations in which I will have to ride a bike without a helmet.	544	2.14	1.40
Information from the media (online sources, magazines, newspaper, T.V.) about bicycle helmet use seems to catch my eye.	540	2.13	1.15
Even if I can't easily find my bicycle helmet, I make myself find it anyways before I ride because I know I will feel safer with a helmet on.	541	2.10	1.45
I make commitments to myself to wear a bicycle helmet.	543	2.09	1.40
I keep a bicycle helmet conveniently located to remind me to wear a helmet.	540	2.09	1.43
I have friends who encourage me to wear a bicycle helmet, even if I do not feel like it.	544	1.99	1.29
Someone in my life makes me feel good when I wear a bicycle helmet.	538	1.87	1.31
I have someone who tries to share his or her personal experiences of helmet use with me.	543	1.68	1.10
I am rewarded by others if I wear a bicycle helmet.	541	1.51	0.98
I reward myself when I wear a bicycle helmet.	540	1.50	1.03

Appendix L

Mean Scores on Each Item of the Processes of Change Questionnaire (by Process of Change)

	Questionnaire Item	*N*	Mean	SD
Experiential Processes	**Consciousness Raising**			
	I have heard that bicycle helmet use reduces the risk of brain injury.	541	4.10	1.20
	I recall information people have given me on the benefits of wearing a bicycle helmet.	543	2.78	1.33
	Information from the media (online sources, magazines, newspaper, T.V.) about bicycle helmet use seems to catch my eye.	540	2.13	1.15
	Dramatic Relief			
	I am afraid of the consequences to my health if I do NOT wear a bicycle helmet.	542	2.82	1.41
	I get upset when I see people who would benefit from wearing a bicycle helmet NOT wearing a helmet.	539	2.33	1.36
	I react emotionally to warnings about the health hazards of NOT wearing a bicycle helmet.	541	2.27	1.24
	Environmental Reevaluation			
	I think that regular bicycle helmet use plays a role in reducing health care costs by reducing the risk of brain injury.	539	3.47	1.34
	I stop and think about the impact I may have on the people I care about if I sustain a brain injury while riding a bicycle because I was NOT wearing a helmet.	541	2.44	1.36
	I consider the view that my bicycle helmet use behaviors serve as a model to others.	544	2.33	1.34
	Self Reevaluation			
	I feel better about myself when I wear a bicycle helmet.	542	2.75	1.39
	I believe that regular bicycle helmet use will make me a healthier person.	538	2.71	1.48
	I feel ashamed or disappointed in myself when I do NOT wear a bicycle helmet.	545	2.15	1.28
	Social Liberation			
	I have found that many people know that wearing a bicycle helmet is good for them.	543	3.38	1.35
	I am aware of more and more people who are regularly wearing a bicycle helmet.	545	2.84	1.19
	I find society changing in ways that makes it easier to wear a bicycle helmet.	539	2.52	1.3
Behavioral Processes	**Counterconditioning**			
	When I am tempted to NOT wear a bicycle helmet, I try to remind myself of the benefits of wearing a helmet.	543	2.52	1.41
	Instead of wearing a hat or nothing on my head when I ride a bicycle, I wear a helmet.	542	2.24	1.45
	Even if I can't easily find my bicycle helmet, I make myself find it anyways before I ride because I know I will feel safer with a helmet on.	541	2.10	1.45
	Helping Relationships			
	I have friends who encourage me to wear a bicycle helmet, even if I do not feel like it.	544	1.99	1.29
	I have someone who tries to share his or her personal experiences of helmet use with me.	543	1.68	1.10
	I am rewarded by others if I wear a bicycle helmet.	541	1.51	0.98

	Self Liberation			
	I believe that I can wear a bicycle helmet regularly.	542	2.85	1.50
	I tell myself that if I try hard enough, I can regularly wear a bicycle helmet when I ride a bike.	542	2.23	1.37
	I make commitments to myself to wear a bicycle helmet.	543	2.09	1.40
	Stimulus Control			
	I make sure that I always have access to a bicycle helmet when I plan to ride a bike.	543	2.25	1.43
	I avoid situations in which I will have to ride a bike without a helmet.	544	2.14	1.40
	I keep a bicycle helmet conveniently located to remind me to wear a helmet.	540	2.09	1.43
	Reinforcement Management			
	If I engage in regular helmet use, I find that I feel safer.	540	2.91	1.49
	Someone in my life makes me feel good when I wear a bicycle helmet.	538	1.87	1.31
	I reward myself when I wear a bicycle helmet.	540	1.50	1.03

Appendix M
Proposed Intervention Techniques Based on TTM

Stage	Intervention	Construct
Precontemplation	Increase Pros of helmet use (e.g., *Helmets decrease head injuries*, *Helmets protect the rider from cars)* ▪ encourage active identification of multiple benefits of helmet use in group discussion format ▪ provide information about how helmets reduce the risk of brain injuries ▪ emphasize importance for protection against factors biker cannot control (e.g., driver of a car)	Decisional Balance
	Promote confidence to wear a helmet ▪ promote helmet use as challenge that can be mastered vs. focusing on limitations to helmet use ▪ personalized follow-up (e.g., regular emails and/or mailings in following months for continued exposure to brain injury and helmet information) ▪ personal contact and guidance, personalized message delivery	Self-Efficacy
	Promote covert and overt activities and experiences that encourage behavior change ▪ increase awareness and personalize brain injury risk of cycling without a helmet [Consciousness Raising] ▪ increase awareness of people in one's life wearing and/or encouraging helmets [Social Liberation] ▪ encourage discussion with peers and mentors who support helmet use [Helping Relations]	Processes of Change
Contemplation	Promote evaluation of Pros and Cons of helmet use ▪ engage even uninterested participants to emphasize the Pros, as a covert shift in weighing of the costs and benefits of helmet use may be occurring ▪ reflect ambivalence	Decisional Balance
	Continue to promote confidence to wear a helmet and decrease Temptation/address limitations ▪ address situations with strong temptation to not wear a helmet (e.g., misconception that helmets are not necessary for short bicycle rides)	Self-Efficacy
	▪ realization that helmet use is consistent with preexisting values/self-image (e.g., value of health, protection of cognitive abilities and independence relied upon during college) [Self-Reevaluation] ▪ use personal testimonies or media campaigns to move participants emotionally [Dramatic Relief] ▪ education about consequences of brain injury; follow-up information distribution [Consciousness Raising] ▪ encourage participants to ask others to help monitor their helmet use [Helping Relations]	Processes of Change
Preparation	Decrease Cons of helmet use (*Wearing a helmet is uncomfortable*, *People tease people who wear helmets*) ▪ provide comfortable fitting helmets for participants try on ▪ share resources to address and minimize negative perceptions of social norms of helmet use (e.g., Will another college student really tease you?) ▪ share resources that promote hairstyles to address "helmet hair"	Decisional Balance
	Self-Efficacy increasing; continue to promote confidence to wear a helmet ▪ provide materials to promote continued exposure to information about helmet use and brain injury (e.g., facts about impact of brain injury on college-aged person, such as the lifetime cost of brain injury) Temptation decreasing; identify obstacles and assist with problem-solving ▪ promote situations that support Confidence (e.g., bicycling with others who are wearing helmets) and decrease Temptation (e.g., when only riding a short distance)	Self-Efficacy
	▪ set a date for helmet use, tell a friend that you will be starting to wear a helmet [Self-Liberation] ▪ highlight changing social norms about importance of concussion prevention [Social Liberation] ▪ suggest that participants counteract situations when helmet use is more difficult (e.g., can't easily find one's helmet) with purposeful thoughts about benefits of helmet use [Counter Conditioning] ▪ place helmet in visible, accessible spot [Stimulus Control]	Processes of Change

<table>
<tr><td rowspan="4">Action/Maintenance</td><td colspan="2">Awareness of continual weighing of costs and benefits of helmet use</td><td>Decisional Balance</td></tr>
<tr><td colspan="2">Continued support of confidence to wear a helmet
▪ encourage involvement with a friend who encourages them in their helmet as needed
▪ exposure to media messages (less personalized) that promote Confidence to wear a helmet (e.g., promote social acceptance of helmet use, ease and accessibility of newer helmet designs)</td><td>Self-Efficacy</td></tr>
<tr><td>Action</td><td>▪ promote rewards for helmet use (e.g., getting a favorite drink on a bike ride when helmet is worn) [Reinforcement Management]
▪ encourage reevaluation of current helmet use behaviors [Self-Reevaluation]
▪ realization of negative effect of one's behavior on his or her environment (e.g., younger siblings or children modeling participant's non-helmet use behavior) [Environmental-Reevaluation]</td><td rowspan="2">Processes of Change</td></tr>
<tr><td>Maintenance</td><td>▪ explore emotional reactions to traumatic bike accidents or brain injury [Dramatic Relief]
▪ place reminder notes to wear a helmet [Stimulus Control]
▪ follow-up contact to ensure helmet accessibility; help identify how choosing to wear a helmet instead of wearing nothing or a hat will promote safety [Counter-Conditioning]</td></tr>
</table>