Application of The Theory of Planned Behavior in a Randomized Control Trial Targeting Sugar-Sweetened Beverage Intake and Physical Activity in Southwest Virginia

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ABSTRACT

BACKGROUND: Health-related interventions informed by behavioral theory have been shown to be more effective in changing behaviors as compared to those that are not. The Theory of Planned Behavior (TPB) has been used to successfully predict and explain a variety of health related behaviors, including sugar-sweetened beverage (SSB) intake and physical activity (PA). The TPB assumes that behavioral intentions are the most important determinant of behavior. Intentions are the function of individual's attitudes toward the behavior (these evaluations can be positive or negative), subjective norms (social standards and expectations surrounding the behavior), and perceived behavioral control (perception of the ease with which the behavior can be performed). According to literature, behavioral intentions predict 20% - 40% of the variance in health behaviors with attitudes beings the strongest predictor of diet, and perceived behavioral control being the strongest predictor of physical activity related intentions. Excessive SSB consumption and inadequate PA have been highly associated with the obesity epidemic, and related comorbidities such as cardiovascular disease and type-2 diabetes. Understanding and targeting these behaviors through application of health behavior theories, such as the TPB, is important.

PRIMARY AIMS: This research is embedded within a larger 2-arm randomized-control trial, Talking Health, which targets residents in rural southwest Virginia. Guided by the TPB, the overall goal of the Talking Health trial is to determine the effectiveness of a 6-month intervention aimed at decreasing SSB intake (SIP*smart*ER) compared to a matched contact control aimed at increasing PA (MoveMore). Each condition includes three classes, one teach-back call, and 11 interactive voice response (IVR) calls. The primary aims of this secondary analysis of Talking Health are to 1) determine if single-item TPB indicators are correlated with multi-item TPB scales for SSB and PA; 2) examine how baseline TPB variables predict participation in the SIP*smart*ER and MoveMore; 3) determine how the IVR TPB variables assessed during IVR calls predict future SSB and PA behaviors reported in a subsequent IVR call; and 4) explore how TPB variables change over the course of the teach back and 11 IVR calls.

METHODS: Eligibility requirements included being 18 years of age or older, having reliable access to a telephone, drinking ≥200 kilocalories of SSB per day, and having no contraindications for moderate-intensity physical activity. The present research utilizes data from the baseline health assessment, class attendance and IVR and teach back calls completion data, as well as data collected in teach-back and 11 IVR calls. Multi-item TPB constructs for both SSB and PA behaviors were assessed at baseline (measured on a 7-point Likert scale). Each IVR call assessed self-reported past week behavior (ounces of SSB or minutes of PA) and four single-item TPB constructs including behavioral intentions, perceived behavioral control, instrumental

attitudes, affective attitudes, and subjective norms. Participation was measured as the number out of 15 activities completed by participants (three classes, one teach back call, and 11 IVR calls). Statistical analysis included descriptive statistics, Chi square tests, independent T-tests, Pearson's correlations, Cronbach's α, and sequential multi-step regression models. Multiple data imputations were used to account for missing data.

RESULTS: Of the 301 participants, 81% were female and 93% were Caucasian. The mean age of participants was 48.8 ± 13.5. Additionally, 32% of participants completed ≤ high school education, 55% earned < $20,000 per year, 32% had a full time or part time job, and 33% were classified as low health literate. Single-item indicators for both SSB-TPB questions ($r > 0.60$) and PA-TPB questions ($r > 0.69$) were highly correlated with their multi-item scales. Baseline TPB variables did not predict the participation rates in either SIP*smart*ER ($F=1.763$, $R^2=0.057$, $P=0.124$) or MoveMore ($F=0.815$, $R^2=0.028$, $P=0.541$) conditions. Of the nine SIP*smart*ER IVR regression models, eight were significant, and the SSB-TPB variables predicted about 30% of the variance in SSB behavior. Of the nine MoveMore IVR regression models, all were significant, and the PA-TPB variables predicted about 20% of the variance in SSB behavior. In both conditions, the majority of variance was explained by behavioral intentions and the addition of other TPB variables (perceived behavioral control, instrumental attitudes, affective attitudes, and subjective norms) explained substantially less variance in the behaviors. There were no notable patterns of change in TPB variables over 11 IVR calls for either SIP*smart*ER or MoveMore participants.

DISCUSSION: Our findings show that single-item indicators can be used as reliable measures of the TPB constructs. The TPB model did not show significant predictive value when it comes to participation in SIP*smart*ER or MoveMore. On the other hand, our findings show that TPB model explained about 30% (SSB) and about 20% (PA) of variance in behavior. Although significant changes in IVR TPB variables were found between the two time points in several instances for both SSB and PA behavior, there were no patterns of change over time. Based on our findings, assessing behavioral intentions as the goal behavior in each IVR call may be the most useful application of the TPB. Other TPB variables can be assessed using single-item indicators.

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LITERATURE REVIEW

Introduction

Increased sugar-sweetened beverage (SSB) intake and low physical activity (PA) have contributed to increasing rates of obesity and related chronic diseases over the past several decades (Kit, Fakhouri, Park, Nielsen, & Ogden, 2013). These trends pose a major public health concern especially among the low-income and low health literate subsets of the population (Thompson et al., 2009). Literature shows that theory-based health interventions have larger effects when compared to those not based on theory (Goldstein, Whitlock, DePue, & Planning Committee of the Addressing Multiple Behavioral Risk Factors in Primary Care, 2004). The Theory of Planned Behavior (TPB) is one of the most widely used behavioral theories and it has been used to successfully predict and explain a variety of health related behaviors, including SSB intake and PA (Icek Ajzen, 1991). By understanding and identifying the TPB constructs related to SSB consumption and PA, culturally sensitive interventions can be developed to target and change beliefs, attitudes, subjective norms, and perceived behavioral control, which may lead to subsequent changes in intentions and SSB and PA behaviors (Zoellner, Estabrooks, Davy, Chen, & You, 2012).

The goal of this literature review is to provide an overview of: 1) current trends in SSB intake, physical inactivity and obesity and related chronic conditions; 2) reviews and applications of the TPB in diet, SSB, and PA behaviors; 3) efficacy of the TPB in predicting health behaviors; 4) factors influencing the TPB efficacy; 5) efficacy of the TPB in predicting participation and patterns or participation; 6) and measurement issues related to the TPB constructs including single-item indicators.

Trends in Health Behaviors and Health Outcomes

Increase in sugar-sweetened beverages intake

Sugar-sweetened beverages are defined as any drink that contains a caloric sweetener, and include soft drinks, fruit drinks, sports drinks, energy drinks, sweetened milk, and tea and coffee with added sugar (Centers for Disease Control and Prevention, 2010). In 2009-2010, US adults consumed an average of 151 +/- 5 calories (kcal) per day, contributing 6.6% +/- 0.2% of daily energy intake (Kit et al., 2013). Although the overall consumption of SSBs in the US is showing a slight decrease, the recommendations of 8 fluid ounces per day, or no more than 450 kcals (36 fl. oz.) per week from SSB's are still being exceeded (Johnson & Yon, 2010). Furthermore, high consumption of SSB (≥500 kcal/day) has actually increased among children by approximately 5% (Han & Powell, 2013). Currently, soft drinks alone account for 33% of total added sugars consumed and are the biggest contributor to added sugar intake in the US (Han & Powell, 2013).

It is important to note that unlike other health related behaviors with adverse outcomes, SSB intake tends to be significantly higher among the population living below the poverty level, and those with lower educational and health literacy levels (Thompson et al., 2009; Zoellner, Estabrooks, et al., 2012). Family income, education status, and race/ethnicity are found to be strongly and independently associated with added sugars intake with low-income and lower education groups being particularly vulnerable (Thompson et al., 2009). This data suggests the importance of targeting interventions aimed at sugar consumption reduction to low socio-economic populations.

Increase in physical inactivity

Although the benefits of moderate-intensity physical activity (150 minutes of cardio activity with strength training two or more times per week) have been well researched and documented, less than 48% of all US adults meet 2008 physical activity guidelines (Centers for Disease Control and Prevention, 2014b). Only 20.6% of adults 18 years of age and over met the Physical Activity Guidelines for both aerobic and muscle-strengthening physical activity in 2011 and about 25% lead sedentary lives (Centers for Disease Control and Prevention, 2014b). Research has shown that even moderate increase in physical activity can prevent obesity, increase the life expectancy, and reduce the risk of death from cancer, heart disease, and other causes (Blair & Morris, 2009). The Task Force on Community Preventive Services has conducted systematic reviews of community interventions to increase physical activity. The behavioral and social approach such as social support interventions in community setting was among six interventions that are strongly recommended (Community Preventive Services Task Force, 2014). Socioeconomic inequities are related to physical activity as well, with those below the poverty level and with lower levels of education being less likely to meet the 2008 physical activity guidelines (Centers for Disease Control and Prevention, 2014b).

Increase in rates of overweight and obesity and related chronic diseases

Increased rates of SSB intake and decreased rates of PA have contributed to the significant increase in the prevalence of overweight and obesity over the past several decades. The obesity rates have been steadily increasing since 1960's among all age and ethnic/racial groups with approximately 78 million (35.7%) of US adults currently falling within the obese category (Ogden, Carroll, Kit, & Flegal, 2014). An objective of Healthy People 2020 is to reduce

the obesity prevalence by 10% to the target of 30.5%. This goal is still far from being reached (Healthy People 2020, 2014).

Additionally, rates of obesity are higher among some US groups than others, with non-Hispanic Blacks having the highest rates of obesity (49.5%), followed by Mexican Americans (40.4%), Hispanics (39.1%), and non-Hispanic whites (34.3) (Centers for Disease Control and Prevention, 2014a). Prevalence of obesity also varies depending on the geographic area and socioeconomic status. Rural areas such as Southwest Virginia (SWVA) tend to be the subject to greater health disparities, with 35% of adults living in SWVA being obese as compared to 27.4% in the state of Virginia (Virginia Performs, 2015).

Effects of overweight and obesity are far reaching, having a serious impact both on health and economy nationally and globally (Hu & Malik, 2010). Epidemiologic studies show that overweight and obesity play an important role in the development of type 2 diabetes, cardiovascular disease, several cancers, and premature death (Fung et al., 2009; Hu & Malik, 2010). Over 50% of all deaths in 2005 were the result of chronic diseases such as heart disease, stroke, cancer, diabetes, obesity, and arthritis (Glanz, Rimer, & Viswanath, 2008). According to the CDC, in 2012, half of all adults had one or more chronic health condition, and seven of the top ten causes of death in 2010 were chronic diseases (*CDC*, 2014). Annual medical cost related to obesity is reported to be $147 billion dollars with cost of the obese individuals being $1,429 higher compare to those of normal weight (Ogden et al., 2014). Time-trends data examining the relationship between obesity epidemic and SSB consumption over the last several decades is showing a close parallel (Hu & Malik, 2010). Increase in SSB consumption and decrease in PA have been identified as main contributors to weight gain, obesity, and related comorbidities (Appelhans et al., 2013; Johnson & Yon, 2010).

Theory of Planned Behavior (TPB)

Overview of the TPB

Literature shows that health behavior interventions that use theory are more effective in changing the behavior when compared to those that do not (Painter, Borba, Hynes, Mays, & Glanz, 2008). Based on the level of influence, health behavior theories are grouped into three categories: individual or intrapersonal, interpersonal, and community level theories (Painter et al., 2008). Individual level behavior theories explore factors influencing individual behavior such as knowledge, skills, beliefs, attitudes, and self-efficacy. The most widely used health behavior theories in literature are: The Health Belief Model (HBM), Theory of Reasoned Action (TRA)/Theory of Planned Behavior (TPB), Social Cognitive Theory (SCT), and Transtheoretical Model (TTM) (Glanz et al., 2008).

The Theory of Planned Behavior (TPB) is an individual level theory that aims to explain and predict behavior, and has been widely applied to studies exploring eating and PA behaviors. The TPB is an extension of the previously developed Theory of Reasoned Action and posits that behavioral intention is the most important determinant of behavior (Icek Ajzen & Fishbein, 1975). Intention relates to the motivation, the willingness to try, and the amount of effort a person is willing to exert in order to change the behavior (Rodgers, Conner, & Murray, 2008). Both TRA and TPB assume that intentions are in turn influenced by attitudes and subjective norms, while the TPB adds an additional construct of perceived behavioral control.

Salient beliefs are a context specific set of beliefs that people attend to when deciding whether to engage in a behavior or not, and it is these beliefs that ultimately determine intentions and actions (Icek Ajzen, 1991). A person can have an unlimited number of beliefs about the behavior, but only some will be salient at any particular point. Salient beliefs (*indirect measures*)

that determine attitudes, subjective norms, and perceived behavioral control (*direct measures*) are behavior, normative, and control beliefs (McEachan, Conner, Taylor, & Lawton, 2011). Attitudes are determined by salient behavioral beliefs about outcomes of performing the behaviors weighted by evaluations of those outcomes. subjective norms are determined by normative beliefs weighted by motivation to comply. perceived behavioral control is determined by control beliefs weighted by perceived power (Mark Conner & Norman, 2005; Glanz et al., 2008)

Attitudes are positive or negative evaluations of the behavior, and according to reviews of TRA/TBP, tend to be the best predictors of intentions (Armitage & Conner, 2001b; Godin & Kok, 1996b) Ajzen and Fishbein conceptualized attitudes based on expectancy-value model which states that the overall evaluation or the attitude towards the object is a function of the beliefs we have about the object in question (Fishbein & Ajzen, 2005). Behaviors with outcomes evaluated as positive are favored, and this subjective evaluation is directly proportional to the strength of the belief. There are two types of attitudes: attitude towards an object, and attitude towards the behavior with respect to the object (ex: an attitude towards PA vs. an attitude towards engaging in PA) (Ajzen & Fishbein, 2005). Attitudes contain both an instrumental (desirable – undesirable) and affective (pleasant – unpleasant) component. While authors tend to disagree about which aspect of the attitudes is more useful, Ajzen and Fishbein (2005) have recently concluded that both aspects of attitudes should be appropriately represented and measured.

Subjective norms relate to social pressure from significant others to engage or to not engage in the behavior. The subjective norms construct is quantified as the product of normative beliefs, defined as the likelihood that referent others will approve/disapprove of the performance

of the behavior, and motivation to comply to these expectations (Icek Ajzen, 1991). Subjective norms construct is often criticized for not capturing the complexity of the influence that norms have on human behavior (Armitage & Conner, 2001b). Several authors suggest that the construct would be strengthened by distinction into moral (personal) and descriptive norms or group and subjective norms (Armitage & Conner, 2001b; Godin & Kok, 1996a). Conner and Armitage (2001) found that moral norms added 4% to the prediction of intention, and Conner and Norman (2005) concluded that the inclusion of moral norms may be valuable when studying behaviors for which moral and ethical considerations are important part of the decision making process. Since subjective norms is typically the construct that shows the weakest relationship with intentions, and subsequently the behavior, taking into consideration how the construct is conceptualized and measured may be important in order to increase its predictive value.

Perceived behavioral control was added to the TRA by Azjen (1991) to account for the behaviors that are not under volitional control. perceived behavioral control is the function of the beliefs about the accessibility of resourses and opportunities to perform the behavior, multiplied by the perceived power of each of those factors and it is defined as perceived ease or difficulty of performing a behavior (Mark Conner & Norman, 2005). It reflects both external factors (social support, environment, and socio-economic status) and internal factors (skills, knowledge, and information). According to Ajzen (1991), the usefulness of the perceived behavioral control construct will increase as the volitional control over the behavior decreases. Unlike the straightforward causal relationship between intention and behavior, the link between perceived behavioral control and behavior is more complex exerting both direct and interactive (via intentions) effect on the behavior (Armitage & Conner, 2001a). When the performance of the behavior is limited by volitional control, perceived behavioral control has the potential to directly

predict the behavior moderating the relationship between intention and behavior (Mark Conner & Norman, 2005).Meta-analytic reviews of literature strongly support the ability of perceived behavioral control to predict intentions (and behavior) when controlling for other TPB constructs, contributing an additional 2% of variance when controlling for intention (Armitage & Conner, 2001). The issue with perceived behavioral control that is commonly raised is the difficulty to establish how well the construct reflects the *actual* (vs. perceived) control (Armitage & Conner, 2001). Additionally, a number of authors, including Ajzen, emphasize the conceptual similarity between perceived behavioral control and self-efficacy (Icek Ajzen, 1991; Armitage & Conner, 2001b; Godin & Kok, 1996a). Bandura (1997), on the other hand, argues that the two constructs are quite different, with self-efficacy capturing the internal cognitive factors, and perceived behavioral control reflecting general external control factors (Bandura, 1995).

The utility of the TPB at predicting and explaining health-related behaviors has been well researched and the following discussion will offer the review of major systematic and meta-analytic reviews of the TPB studies.

How effective is the TPB in predicting health behaviors

The TPB has been used to study a wide range of behaviors, including many health behaviors such as smoking, drinking, exercise, and substance use (Godin & Kok, 1996a). Most of these studies are cross-sectional and longitudinal in design, with very few intervention studies. Glanz et al. (2008) recommends the use of prospective design for studies that use the TPB as their theoretical framework. This allows for the predictive ability of the variables to be clearly measured since TPB variables and behavior are assessed at different time periods (Glanz et al., 2008). Cross-sectional TPB studies, which are used more often, assess theoretical constructs and

the behavior at the same time point, and are thus criticized for poor prediction (Glanz et al., 2008).

Behavioral intention is typically found to be the strongest and often the only independent predictor of health behaviors, with attitudes often being reported as the strongest predictor of diet, and perceived behavioral control being reported as the strongest predictor of PA related intentions (Godin & Kok, 1996a). Reviews of literature show that behavioral intention typically explains 20-40% of the variance in behavior, whereas attitude, subjective norms, and perceived behavioral control explain 40-50% of the variance in intention (Armitage & Conner, 2001b; Godin & Kok, 1996b; McEachan et al., 2011).

In a review of 56 health-related studies, Godin and Kok (1996) found the intention to be the best predictor of the behavior, explaining 66.2% of the variance. Attitudes, subjective norms, and perceived behavioral control explained 46%, 34%, and 46% of the variance in intention, respectively. For both eating and exercise behaviors, attitude was the strongest predictor of intentions (34% and 51%) followed by perceived behavioral control (32% and 50%) (Godin & Kok, 1996b). Correlations were higher for exercise when compared to eating behaviors for all variables, with subjective norms explaining the lowest percentage of the variance in the intention (Godin & Kok, 1996). When it comes to the prediction of the behavior itself, the efficiency of the TPB was not consistent. It was found to be low for clinical and screening behaviors, and much higher for addictive and HIV/AIDS related behaviors. Type of the behavior played a significant role in the ability of the model to efficiently predict behavior (Godin & Kok, 1996).

In a meta-analysis of 206 TPB studies, McEachan et al. (2011) found TPB constructs to be effective predictors of both intentions and the behavior, accounting for 40-49% of the variance in intentions, and 26-36% of the variance in behavior (McEachan et al., 2011). These

findings are consistent with Godin and Kok's where variance in intention was also higher when compared to the variance in the behavior (66% vs. 34%). In the same meta-analysis, the TPB was found to be the most effective at predicting PA (23.9% variance) and dietary behaviors (21.2% variance) with attitudes being the strongest predictor of intentions, and intentions being the strongest predictor of all types of behaviors (Godin & Kok, 1996b; McEachan et al., 2011). Among other health behaviors included in the meta-analysis were risk, detection, safer sex, and abstinence from drugs, which were poorly predicted by the TPB when compared to physical activity and dietary behaviors (McEachan et al., 2011).

Similarly to previous findings, in meta-analysis of 185 independent studies, Armitage and Conner found that the TPB accounted for 27% and 39% of the variance in behavior and intention, respectively (Armitage & Conner, 2001b). perceived behavioral control was found to explain 2% of additional variance in behavior, above the intention, proving the ability of the construct to independently predict behavior. The correlation between perceived behavioral control and intention was also strong, with perceived behavioral control independently accounting for the 6% of the variance when controlling for attitudes and subjective norms (Armitage & Conner, 2001b).

While some of the systematic reviews mentioned previously show that the TPB constructs can predict as much as 60% of the variance in intentions, the prediction of the behavior did not go over 36%. Overall, the TPB was shown to have good predictive value when used to explain numerous health behaviors, including dietary behaviors and physical activity and has often been used as a theoretical framework in interventions targeting these behaviors. The application of the TPB in the studies of dietary behaviors and SSBs will be discussed next.

Application of the TPB to explain dietary behavior and SSB intake

The TPB has been used to study numerous dietary behaviors including fat intake, fruit and vegetable intake, SSB consumption, vitamin supplementation, soy and dairy consumption, and overall healthful diet consumption (Armitage, 2004; Armitage & Conner, 2001a; Backman, Haddad, Lee, Johnston, & Hodgkin, 2002; Bogers, Brug, van Assema, & Dagnelie, 2004; M. Conner, Kirk, Cade, & Barrett, 2001; M. Conner, Norman, & Bell, 2002; de Bruijn & van den Putte, 2009; Kassem & Lee, 2004; Kassem, Lee, Modeste, & Johnston, 2003; Kim, Reicks, & Sjoberg, 2003; Masalu & Astrom, 2001; Pawlak, Malinauskas, & Rivera, 2009; Povey, Conner, Sparks, James, & Shepherd, 2000b; Rah, Hasler, Painter-, & Chapman-Novakofski, 2004; Tipton, 2014; Zoellner et al., 2014; Zoellner, Estabrooks, et al., 2012; Zoellner, Krzeski, et al., 2012). Although Godin and Kok (1997) found that the TPB performed poorly in the assessment of eating behaviors, several studies conducted since then have proved that the TPB can be a useful model for predicting and explaining a variety of dietary behaviors (Armitage, 2004; Armitage & Conner, 2001a; Backman et al., 2002; Bogers et al., 2004; de Bruijn & van den Putte, 2009; Kim et al., 2003; Pawlak et al., 2009; Povey et al., 2000b). The majority of identified diet and SSB related TPB studies were cross-sectional and longitudinal in design. However, since the TPB is commonly used to study diet and PA behaviors, the literature review presented here was not comprehensive. Studies reviewed here present an illustration of the TPB application in studying these behaviors.

Cross sectional studies. Cross-sectional studies identified for this literature review examine variety of nutrition and diet related behaviors including fruits and vegetable and fat intake (Bogers et al., 2004; Povey, Conner, Sparks, James, & Shepherd, 2000a), dairy consumption among elderly (Kim et al., 2003), vitamin supplement use among women (M. Conner et al., 2001), healthy diet choices (Pawlak et al., 2009), and overall healthy eating (Povey

et al., 2000b). Predictive ability of the TPB is expected to be better in cross-sectional when compared to other study designs (longitudinal and intervention studies). This is possibly due to the fact that beliefs that are salient at the time when study participants are filling out the TPB questionnaire and those accessible when performing the actual behavior will be the same, since both happen at

Table1.1: Theory of Planned Behavior cross-sectional studies related to diet and SSB behaviors

Article Title	**Authors (Year)**	**Target population (n)**	**Variance in intention**	**Variance in behavior**
Application of the TPB to 2 dietary behaviors: roles of perceived behavioral control and self-efficacy	Povey & Conner *(2000)*	Members of general public (n=287)	63.7% (fat) 57.2% (fruits and vegetables)	18.5% (fat) 32.1% (fruits and vegetables)
Applying the TPB to predict dairy product consumption by older adults	Kim, et al. *(2003)*	Older adults (n=162)	43.4% of the variance in intention	39.4% (intention and perceived behavioral control)
Applying the TPB to women's behavioral attitudes on and consumption of soy products	Rah et al. *(2004)*	Convenience sample of black and white women (n=205)	57% of variance in intention	59% of variance in behavior (intentions)
Predicting intentions to eat a healthful diet by college baseball players: applying TPB	Pawlak et al. *(2009)*	Male undergraduate baseball players (n=50)	72% of variance in intention	N/A
Understanding soft drink consumption among female adolescent using the TPB	Kassem et al. (2003)	Female students (13-18) in LA public schools (n=707)	64% of variance in intention	28% of the variance in behavior (intention and perceived behavioral control)
Understanding soft drink consumption among male adolescents using the TPB	Kassem & Lee *(2004)*	Male adolescents (n=564)	64% of variance in intention	15% of variance in behavior (intention and perceived behavioral control)
Using TPB to understand caregiver's intention to serve SSB's to non-Hispanic black preschoolers	Tipton (2014)	Caregivers (n-165)	45.1% of variance in intention	N/A
Exploring the TPB consumption to explain SSB intake	Zoellner et al. *(2012)*	Residents of SWVA (n=119)	34 % by attitudes 16% by subjective norms 32% by perceived behavioral control	51% of variance in behavior

the same point in time (Conner & Norman, 2005). We will illustrate the application of the TPB in cross-sectional studies by providing several examples below.

In a study exploring the usefulness of the TPB to explain the decision to eat healthy, the TPB constructs overall explained 42% of the variance in intention, and 15% of the variance in behavior (Povey et al., 2000b). Kim et al. (2003) found intentions to be the strongest predictor of dairy product consumption among adults explaining 61% of the variance in behavior, with attitudes being the strongest predictor of intention. Similarly, intention explained 59% of the variance in soy consumption among women, while attitudes contributed 57% to the variance in intention (Rah et al., 2004). In a study done by Pawlak at al. (2009) TPB constructs explained as much as 72% in behavioral intentions to eat a healthful diet among college baseball players.

The application of the TPB to SSB behaviors is limited, with the majority of studies focusing on adolescents and children, and their caregivers (de Bruijn & van den Putte, 2009; Kassem & Lee, 2004; Kassem et al., 2003; Tipton, 2014; Zoellner et al., 2014; Zoellner, Estabrooks, et al., 2012). In a study of 707 female students in Los Angeles public schools attention, subjective norms and perceived behavioral control explained 64% of the variance in intention, with attitudes being the best predictor of intention, followed by subjective norms and perceived behavioral control (Kassem et al., 2003). Intention was the only significant independent predictor of the SSB consumption with intention and perceived behavioral control combined predicting 28% of the variance (Kassem et al., 2003). In a similar study of 564 male students, attitudes, subjective norms, and perceived behavioral control explained 61% of the variance in intention to drink regular soda (Kassem & Lee, 2004). Intention was found to be the only significant independent predictor of the behavior, with intention and perceived behavioral control explaining 15% of the variance on behavior (Kassem & Lee, 2004). In another study

examining the application of TPB to SSB behavior among 312 Dutch adolescents, stronger habit towards soft drink consumption was found to be significantly associated with higher consumption, supporting previous studies in which the habit strength has an important mediating effect in the context of health behaviors (de Bruijn & van den Putte, 2009). Higher perceived behavioral control was in turn associated with stronger intention to limit the consumption of soft drinks (De Bruijn & van den Putte, 2009).

In a study examining the caregiver's intentions towards SSB and their influence on their children intake, the TPB constructs accounted for nearly 48% in the variability in intention to serve SSB's to children, with attitudes and intention explaining 45.1% of the variance in intention, while no relationship was found between perceived behavioral control and intention, proving that TRA was a better fit in this context (Tipton, 2014). The study supports previous research findings in which the TPB explained 44% to 64% of the variance in soft drink consumption among youth (Kassem and Lee, 2004; Kassem et al. 2003).

The TPB has also been applied to cross-sectionally study the SSB consumption among adults. In a formative cross-sectional study among low-income, low-health literate residents of southwest Virginia, the TPB components explained 38% of the variability in the behavioral intentions (Zoellner, Estabrooks, et al., 2012). Compared to the average of 25% and 34% found in comparable eating behavior TPB studies in Godin's review of 25 TPB applications, this application of TPB-SSB model performed very well. Behavioral intentions had the strongest influence on the behavior, followed by attitudes, perceived behavioral control, and subjective norms (Zoellner, Estabrooks, et al., 2012). Intentions independently explained 51% of the variance in the SSB behavior, with attitudes explaining 63%, perceived behavioral control 54%, and subjective norms 36% of the variance in intentions (Zoellner, Estabrooks, et al., 2012).

In reviewed diet and SSB related TPB studies using cross-sectional design, behavioral intention has consistently been reported as the most significant predictor of behavior, with attitudes being the strongest predictor of intentions. Next, we will review diet and SSB related longitudinal studies, using TPB as their theoretical framework.

Longitudinal studies. There are fewer diet and SSB longitudinal studies based on the TPB when compared to those of cross-sectional design. Consistent with the view that length of follow-up is the factor influencing efficacy of the TPB to predict the behavior (Conner & Norman, 2005), variance in dietary and SSB behaviors in studies reviewed was lower when compared to cross-sectional studies, with only three longitudinal studies reporting the variance in behavior that exceeded 30% (Armitage & Conner, 1999; De Bruijn et al., 2007; Nejad et al., 2004).

On the other hand, magnitude of variance in intention was comparable across most of the longitudinal and cross-sectional studies reviewed. Interestingly however, one study compared the variance in intention cross-sectionally and prospectively in a TPB study examining healthy eating habits, and found that TPB variables explained 43% of variance in intention cross-sectionally, when compared to 20% prospectively (M. Conner et al., 2002). The same study however, found the TPB to be predictive as long as 6 years later, with intention explaining 9% of the variance in the behavior, showing that the TPB variables can potentially have predictive value even across very long follow-ups (M. Conner et al., 2002).

In two related TPB studies, intention was found to be the best predictor of healthy food choice and low-fat diet behaviors explaining 57% and 21% of variance in behavior, respectively (Armitage & Conner, 1999a; Armitage & Conner, 1999b). TPB variables explained 57% of the variance in intention to make healthy food choice, and 60% of the variance to eat a low-fat diet.

Table 1.2: Theory of Planned Behavior longitudinal studies related to diet and SSB behaviors

Article Title	**Author(s) (Year)**	**Target population (n)**	**Variance in intention**	**Variance in behavior**
The TPB and healthy eating	Conner, et al (2002)	Health promotion clinic attendees (n=144) Follow-up: 6 years	20% prospectively 43% cross-sectionally	9% of the variance in behavior 6 years later
Predictive validity of the TPB: The role of questionnaire format and social desirability	Armitage & Conner (1999a)	Participants from North, UK (n=110) Follow-up: 1 month	57% of variance in intention	18% with FFQ 39% with 2 item measure
Distinguishing perceptions of control from self-efficacy: predicting consumption of low fat diet using the TPB	Armitage and Conner (1999b)	Undergrads from Leeds University (n=221) Follow-up: 1 month	60% of variance in intention	21% of the variance in behavior with self-reports
Does habit strength moderate the intention-behavior relationship in the TPB? The case of fruit consumption	De Bruijn et al. (2007)	Dutch adults (n=521) Follow-up: 5 weeks	N/A	36% by intention in low habit 30% in medium 5% in high
Psychosocial predictors of healthful dietary behavior in adolescents	Backman et al. (2002)	Adolescents (14-19 year olds) from California (n=780) Follow-up: 1 month	42% variance in intention	17% of variance in behavior (intention)
Predicting dieting behavior by using, modifying, and extending the TPB	Nejad et al. (2004)	Female undergraduates (n = 256) Follow-up: 3 months	77% in intention to diet 33% in follow up	46% in variance in follow up dieting
Predicting intended and self-perceived sugar restriction among Tanzanian students using the TPB	Masalu and Astrom (2001)	Tanzanian students (n=226) Follow-up: 4 weeks	33% of variance in intention 44% with perceived	25% (intention) 18% (PBC)

Both studies concluded that the addition of self-identity construct adds ~5% to the variance in intention (Armitage & Conner, 1999a; Armitage & Conner, 1999b).

Intention was also found to be a significant predictor of fruits and vegetable intake (De Bruijin, 2009), healthful dietary behavior among adolescents (Backman et al., 2002; Nejad, Wertheim, & Greenwood, 2004), and sugar consumption among Tanzanian students (Masalu & Astrom, 2001). In the TPB application to study fruit consumption among 521 Dutch adults, De Bruijn et al. (2007) examined the moderating effect of habit strength on intention behavior relationship, and concluded that the intention is significant predictor with low and medium, but not high habit explaining only 5% of the variance in behavior.

In a study of healthful behaviors among 780 adolescents from California, Backman et al. (2002) found the TPB variables to explain 42% of the variance in intentions with attitudes being the strongest predictor of intentions. Investigating the dieting behavior among similar population in Australia (256 female undergraduates), Nejad et al. (2004) found as much 77% of the variance in intention, and 45% of the variance in follow-up behavior. On the other hand, attitudes and subjective norms combined explained 33% of the variance in intention to limit sugar intake among 226 Tanzanian students, with perceived behavioral control explaining 44% of the variance independently (Masalu & Astrom, 2001). The comparison of these three studies shows that the relative importance of the TPB components depends on the cultural context and population studied.

Only three TPB intervention studies of diet and SSB behaviors were identified, and will be briefly reviewed next.

Intervention studies. The TPB has been applied in interventions designed to reduce dietary fat intake (Armitage, 2004), to limit frequency of infant's sugar intake (Beale & Manstead, 1991),

Table 1.3: Theory of Planned Behavior intervention studies related to diet and SSB behaviors

Article Title	**Authors(s) Year**	**Target population (n)**	**Variance in intention**	**Variance in behavior**
Evidence that implementation intentions reduce dietary fat intake: a randomized trial	Armitage (2004)	Participants from North, UK (n = 264)	N/A	Significant between group differences
Predicting mother's intentions to limit frequency of infant's sugar intake: testing the TPB	Beale & Manstead (1991)	Mothers of 5-7 month old babies(n=162)	16% at 1st interview 27% at 2nd interview	N/A
Promoting fruit and vegetable consumption. Testing an intervention based on the TPB	Kothe, Mullan & Butow (2012)	Undergraduate students from Australian University (n=194)	44.5% at baseline 55.1% at follow-up	16.8% at baseline 24.3% at follow-up
Randomized control trial of a brief theory-based intervention promoting breakfast consumption	Kothe, Mullan & Amaratunga (2011)	Students at Australian University (n=349)	39.3% at baseline	33% at follow-up

and to promote fruit and vegetable (Kothe, Mullan, & Butow, 2012) and breakfast consumption (Kothe, Mullan, & Amaratunga, 2011).

Armitage (2004) conducted a randomized control trial hypothesizing that formation of implementation intentions can lead to subsequent behavior change. During a month long intervention among 264 employees from a company in North, UK, an experimental group was required to form implementation intentions, and control group was not (Armitage, 2004). Significant in between group differences were found in the amount of dietary fat consumed, which led to the concussion that the addition of the implementation intentions (defined as plans that ensure that decisions are acted upon) to the TPB can significantly improve the model (Armitage, 2004). Implementation intentions fill the gap between the preparation and action offering volitional strategies necessary for health interventions to be effective (Armitage, 2004).

Experimental design was also used to explore the intention of 162 mothers to limit sugar intake of five to seven month old babies (Beale & Manstead, 1991). Experimental group received dental health education and control did not, and both groups were interviewed at baseline and at twenty-day follow-up (Beale & Manstead, 1991). Change in intention was not significant between the groups, but change in attitudes in experimental group was large perceived behavioral control increased the explained variance in behavior by 4.5% at baseline and 5.8% at the follow-up (Beale & Manstead, 1991).

In a TPB informed study designed to increase the consumption of fruits and vegetables, intention was the most significant predictor of behavior at follow-up (Kothe et al., 2012). The TPB based messages in this study designed to increase the fruits and vegetables consumption were delivered via email to both intervention and control group (Kothe et al., 2012). Model explained 55.1% of the variance in intention to increase fruit and vegetable consumption, and

24.3% of the variance in behavior (Kothe, 2012). When the efficacy of the TPB in predicting regular breakfast consumption was put to test in a four-week intervention, theory components and breakfast consumption did not show any improvement (Kothe, 2011). However, baseline intention did predict 33% of the breakfast consumption at four weeks follow-up, with baseline attitudes, subjective norms, and perceived behavioral control predicting 39.3% of baseline intentions (Kothe, 2011).

Qualitative studies. Four qualitative studies based on principles of the TPB have been identified. Guided by the idea that understanding underlying beliefs and needs is essential for increasing the fruit and vegetable consumption, Brug et al. (1995) conducted an explorative study among 29 Dutch adults using focus groups. Six themes associated with fruits and vegetables consumptions emerged including taste, social influences, perceived health consequences, and skills and barriers (Brug, Debie, Vanassema, & Weijts, 1995). In a study that sought to qualitatively explore eating behaviors among Spanish women using semi-structured interviews, it was found that positive beliefs lead to more positive attitudes (Barberia, Attree, & Todd, 2008). Higher perceived behavioral control was associated with the perception of social support, and was decreased with the perception of the lack of willpower (Barberia et al., 2008).

One study applied TPB to qualitatively investigate beliefs underlying SSB consumption (Zoellner, Krzeski, et al., 2012). Cultural perspectives and target population's specific beliefs regarding the attitudes, subjective norms, and perceived behavioral control in the context of SSB's and water consumption were explored. This was the first study to qualitatively explore beverage consumption among adults using the TPB, providing deeper understanding of underlying cultural beliefs that guide beverage choices (Zoellner, Krzeski, et al., 2012). Beliefs

that emerged as a result of the study provided the basis for the development of culturally and regionally sensitive messages needed for the development of successful intervention.

Conclusion. In TPB studies (cross-sectional, longitudinal, intervention, and qualitative) used to explain dietary behaviors including SSB consumption, behavioral intention has been found to be the strongest predictor of the behavior. In studies that explored antecedents to intention, attitudes had the strongest influence in majority of the studies. Most of TPB-SSB studies have been focused on children and adolescents (de Bruijn & van den Putte, 2009; Kassem et al., 2003; Masalu & Astrom, 2001; Tipton, 2014), with one study applying the TPB on study of SSB consumption among adults (Zoellner, Estabrooks, et al., 2012; Zoellner, Krzeski, et al., 2012).Thompson et al. (2009) Both quantitative and qualitative application of the TPB in this study was useful in predicting the SSB behavior among adults (Zoellner, Estabrooks, et al., 2012; Zoellner, Krzeski, et al., 2012). Next, we will briefly review the application of the TPB in the study of PA.

Application of the TPB to explain PA behavior

Systematic reviews of TPB studies related to PA and exercise show that the intention is the strongest predictor of behavior explaining over 40% of variance (Godin, 1994; Godin & Kok, 1996b) with the TPB model as a whole being less predictive and explaining approximately 20% of variance in PA behavior (McEachan et al., 2011). The TPB was found to be a good fit for the study of exercise in part due to the perceived behavioral control component, which accounts for the beliefs about factors that can inhibit or facilitate the participation in exercise program (Blue, 1995; Hagger, Chatzisarantis, & Biddle, 2002). In the review of 23 studies examining the ability of behavioral intention to predict the engagement in exercise, the TPB was found to be more useful when compared to the TRA mainly due to the inclusion of the perceived behavioral

control construct which significantly added to the variance explained by intention (Blue, 1995). Perceived behavioral control seems to be an important component in understanding PA behavior, with the construct adding 4% to 20% to the explanation of behavior (Godin, 1994).

Elicitation studies based on TPB conducted with the aim of understanding populations' salient exercise beliefs may help in the process of understanding the mechanism underlying the PA behavior (Downs & Hausenblas, 2003). Understanding psychosocial antecedents to PAwould help develop theory-driven interventions aimed at targeting the beliefs underlying the behavior.

Cross-sectional studies. Three cross-sectional studies of PA behaviors were identified for the purpose of this literature review (Eves, Hoppe, & McLaren, 2003; Martin, Oliver, & McCaughtry, 2007; Rhodes & Courneya, 2003). Rhodes and Courneya (2003) used five-factor model of personality to test the hypothesis that the TPB is not sufficient to account for personality characteristics. They concluded that extraversion has an important impact on exercise, even when controlling for the TPB variables (Rhodes & Courneya, 2003).

Examining the efficacy of TPB to predict different types of PA among 233 participants, Eves et al. (2003) found that intention was determined by affective attitudes and perceived behavioral control, with perceived behavioral control having unique contribution to all types of PA behaviors. Contrary to systematic reviews, perceived behavioral control did not have significant influence on the behavior in this study, which was determined by intentions alone (Eves et al., 2003). TPB model as a whole explained 40% of the variance in intention (Eves et al., 2003). Similarly to these findings, Martin et al. (2007) found attitudes, subjective norms and perceived behavioral control to contribute 45% to the variance in intentions in a study of PA behavior of 475 Mexican American children. TPB as a whole added 8-9% of the variance in the

behavior, which is consistent with what is typically seen in TPB studies of physical activity (Martin et al., 2007).

Longitudinal studies. In four reviewed longitudinal studies related to exercise and PA, TPB variables explained significant change in the behavior intention, with intentions and perceived behavioral control having the largest impact on behavior in majority of the studies (Armitage, 2005; Brenes, Strube, & Storandt, 1998; Gardner & Hausenblas, 2005; Norman, Conner, & Bell, 2000).

Table 1.4: Theory of Planned Behavior cross-sectional studies related to physical activity

Article Title	**Author(s) (Year)**	**Target population (n)**	**Variance in intention**	**Variance in behavior**
Relationship between personality an extended theory of planned behavior and exercise behavior	Rhodes & Courneya (2003)	Study 1: Undergraduate students (n=303) Study 2: Cancer survivors (n=302)	N/A	Extraversion has an important impact on exercise behaviors even when controlling for TPB variables
Prediction of specific types of PA using the TPB	Eves, Hoppe & McLaren (2003)	Students and members of community (n=233)	40% of variance in intention	39% of variance in behavior
The TPB: predicting physical activity in Mexican American children	Martin, Oliver & McCaughtry (2007)	Mexican American children (n=475)	45% of variance in intention	8-9% of variance in behavior

Table 1.5: Theory of Planned Behavior longitudinal studies related to physical activity

Article Title	**Author(s) (Year)**	**Target population (n)**	**Variance in intention**	**Variance in behavior**
The TPB and exercise: evidence for the moderating role of past behavior	Norman, Conner & Bell (2000)	Patients attending health promotions clinics (n=87) Follow-up: 6 months	53% of variance in intention	15% of variance in behavior (intention and perceived behavioral control)
Can the TPB predict maintenance of PA?	Armitage (2005)	People enrolling in gymnasium (n = 94) Follow-up: 12 weeks	49% of variance in intention	22% of variance in behavior (intention and perceived behavioral control)
An application of the TPB to exercise among older adults	Brenes, Strube, & Storandt; (1998)	Older adults (n=105) Follow-up: 1, 3, and 9 months	N/A	9% of variance in behavior at 1 month, but not sig at 3 and 9 month perceived behavioral control 27% at 1 month and 10% at 3 month
Understanding exercise and diet motivation in overweight women enrolled in a weight-loss program: a prospective study using the TPB	Gardner & Hausenblas, (2005)	147 women enrolled in wt. loss program	Exercise intention and diet intention not predicted by TPB constructs	Diet adherence predicted by intention Exercise adherence not predicted by TPB constructs

TPB variables explained 53% of the variance in intention among 87 patients attending health promotions clinics, with perceived behavioral control being the only significant independent predictor of intentions (Norman et al., 2000). Perceived behavioral control and intention explained 15% of the variance in behavior, and perceived behavioral control was the only significant independent predictor, with past behavior adding 5% to the behavior prediction (Norman et al., 2000). Armitage (2005) investigated the ability of the TPB to predict maintenance of physical activity and his findings were very comparable. Among 94 participants enrolled in a gymnasium, TPB explained 49% of the variance in intention, with perceived behavioral control and intention combined explaining 22% of the variance in behavior. Perceived behavioral control was again the only significant independent predictor of the behavior (Armitage, 2005). It is worth noting that the study done by Armitage was 12 weeks long, whereas the one done by Norman et al. was 6 months long. Comparison of these two studies showed that the shorter follow-up might be associated with the better predictive value of the TPB (22% vs. 15% of the variance in behavior).

Contrary to these findings, in the TPB study of exercise behavior among 105 older adults intentions did not significantly predict behavior (Brenes et al., 1998). Perceived behavioral control explained 27% of the variance in behavior at 1-month follow-up, but decreased to 10% at 3 months follow-up, which is consistent with previous findings related to the impact of the follow-up length (Brenes et al., 1998). Interestingly, when comparing the motivation to exercise and eat healthy among 147 women enrolled in a weight loss program, Gardner & Hausenbas (2005) found that the intention predicted diet but not exercise adherence. Neither diet nor exercise intentions were predicted by the TPB variables in this study (Gardner & Hausenblas, 2005).

Intervention studies. The TPB is commonly used to inform physical activity interventions. Thee experimental studies were identified to illustrate the TPB application in physical activity based interventions (Ahmad et al., 2014; Chatzisarantis & Hagger, 2005; Darker, French, Eves, & Sniehotta, 2010). Ahmad et al. divided 65 sarcopenic elderly adults into

Table 1.6. Theory of Planned Behavior intervention studies related to physical activity

Article Title	**Author(s) (Year)**	**Target population (n)**	**Variance in intention**	**Variance in behavior**
Applying theory of planned behavior to predict exercise maintenance in sarcopenic elderly	Ahmad et al. (2014)	Older adults (n=65)	63% variance in intention at baseline 47% at 12 weeks	43% variance in behavior at baseline 44% at 12 weeks (intention and perceived behavioral control)
Effects of a brief intervention based on the TPB on leisure time PA participation	Chatzisarantis & Hagger (2005)	Young people (n=83)	Group presented with persuasive message targeting salient beliefs reported more positive attitudes and stronger intentions than control	Neither group reported was influenced when it comes to PA participation
An intervention to promote walking amongst the general population based on an 'extended' TPB: a waiting list randomized controlled trial	Darker et al. (2009)	UK adults (n=130)	Not reported perceived behavioral control, intentions, and attitudes increased	Not reported Minutes walking increased

exercise and control group and found the TPB variables to explain 63% of the variance in intention at baseline, and 47% at 12 weeks among the exercise group. Prediction of exercise behavior from intentions and perceived behavioral control in experimental group, however, was comparable at baseline and follow-up explaining 44% and 43% of the variance respectively (Ahmad et al., 2014).

Study by Chatzisarantic & Hagger (2005) explored the effects of persuasive messages influencing salient beliefs related to physical activity among 65 young adults. They found that the group presented with persuasive messages developed more positive attitudes and stronger intentions when compared with the control (Chatzisarantis & Hagger, 2005). However, there was no change in physical activity participation in either group (Chatzisarantis & Hagger, 2005).

Perceived behavioral control is often identified as the most important determinant of physical activity intentions, including walking (Darker et al., 2010). In an intervention study of 130 adults in UK, designed to increase perceived behavioral control and create walking plans, attitudes, perceived behavioral control, and intentions improved over the course of the interventions, and the objectively measured walking minutes increased by 12 minutes per day (Darker et al., 2010).

The relationship between the psychosocial constructs and the behavior is often influenced by a variety of personal and environmental factors, and several of the most important ones will be reviewed next.

Factors Influencing Cognitions-Behavior Relationship Within The TPB

Past behaviors, length of follow-up, self-identity, and habit strength are some of the factors that may need to be considered when determining how well the TPB is able to predict specific behaviors (McEachan et al. 2011; Conner & Norman, 2005; Sheeran, Orbell, &

Trafimov, 1999b; Armitage & Conner, 1999a; Armitage & Conner, 1999b; Povey et al., 2000; De Bruijn et al., 2007).

Past behavior. Past behavior was found to explain 7.2% (Conner & Norman, 2005) to 19% (Hagger et al., 2002) of the variance in behavior when controlling for TPB constructs. In a study of 144 health promotion clinic attendees, examining the power of the TPB to predict long-term healthy eating intentions, Conner et al. found the model to be successful in predicting health behaviors 6 years later with intentions explaining 9% of the variance (M. Conner et al., 2002). They also examined the role of past behaviors and the moderating role of intentions stability, finding that past behavior drives future behavior only when the intentions are not stable. Temporal stability of intentions (and other TPB constructs) is defined as the "extent to which the cognitive variable remains unchanged over time regardless of whether or not it is challenged" (Sheeran, Orbell, & Trafimov, 1999b). In cases of realistic expectations and well-developed plans for the implementation of intentions, the effect of past behaviors is minimal (I. Ajzen, 2002). Since stable intentions are more likely to be translated into action, temporal stability of intentions could act as a potential moderator explaining the likelihood of behavior performance (Conner et al. 2002).

Length of follow-up. When it comes to the length of follow-up, the overall efficacy of the TPB is better with shorter when compared to longer follow-ups (McEachan, 2011). Conner and Norman (2005) state that the applications of TPB typically do not take emotions (which may be relevant to a number of health behaviors) into account and emphasize that the differences between the contemplation of the behavior (when a participant is filling out a questionnaire) and the attitudes/emotions related to the performance of the actual behavior in real life setting can lead to the poor predictive ability of TPB constructs. If beliefs are salient at the time when the

study participant is filling out the questionnaire are quite different than the beliefs activated in the context of the behavior performance, then the attitudes, subjective norms, and perceived behavioral control assessed initially won't represent those relevant at the behavioral situation (Conner & Norman, 2005; Armitage & Conner, 1999a; Armitage & Conner, 1999b). Self-identity, social influence variables, and habit strenght are additional variables suggested as potential moderators of TPB efficacy (Brug, de Vet, de Nooijer, & Verplanken, 2006; de Bruijn & van den Putte, 2009; Povey et al., 2000b).

Self-identity. In a TPB study of health-related food choice among 110 residents of North, UK, Armitage and Conner (1999a) found that self-identity explained the additional 4% of the variance in intention, exhibiting the ability to independently predict the intention across all conditions (Armitage & Conner, 1999a). Related study exploring the usefulness of the TPB in predicting the low fat diet consumption done by same authors, self-identity added the additional 5% of the variance in intention (Armitage & Conner, 1999b). Based on these findings, Armitage and Conner concluded that self-identity is a valuable additional construct to the TPB model (Armitage & Conner, 1999a; Armitage & Conner, 1999b).

Habit strength. Exploring the moderating effects of habit strength in the intention-behavior relationship in the context of fruit consumption among 521 Dutch adults, De Bruijn & van den Putte (2009) found that the intention was a significant predictor of fruit consumption in low habit (.36) and medium habit group (.30) but not in the high habit group (.05). Habit strength may put a "boundary limitation" on the applicability of the TPB, with intentions being less predictive as habit strength increases (de Bruijn & van den Putte, 2009). Among those with strong habits (dietary and physical activity behaviors tend to be habitual), health behavior change may be more dependent on environmental as opposed to behavioral manipulations, which may

have useful practical application in health behavior interventions (de Bruijn & van den Putte, 2009).

Being able to predict the participation and attendance patterns would also have useful practical implications, and this topic will be discussed next.

The TPB and Prediction of Participation

Although the TPB can successfully predict intentions and goal formation, the model has been criticized when it comes to its ability to predict goal pursuit, attendance/participation, as well as the pattern and frequency of participation (Sheeran, Conner, & Norman, 2001). The consistency in performing a health behavior is essential since most health behaviors need to be repeated for benefits to occur. Being able to predict the frequency and patterns of attendance/participating would thus have very positive practical and theoretical implications. Behavior maintenance and relapse avoidance seem to be key issues in changing health behaviors (Sheeran et al., 2001).

In longitudinal study of attendance for health screening whose purpose was to examine whether the TPB can explain the adoption and maintenance of a new health behavior, behavioral intentions and perceived behavioral control were significant predictors of attendance and frequency, but not the behavior patterns (Sheeran et al., 2001). The TPB was only able to discriminate between patients who never showed up, and those who showed up at least once, which is an important limitation when it comes to prediction of patterns. When the behavior is new, lack of experience seems to be associated with less stable intentions, which also plays a role when it comes to the ability of the model to predict the behavior (Kashima & Gallois, 1993; Sheeran & Orbell, 1999; Sheeran, Orbell, & Trafimow, 1999). The proposed strategy to

overcome this apparent limitation of the TPB is to consistently use the implementation intentions, which improve the speed of action initiation (Sheeran et al., 2001).

Measurement of the TPB constructs, including single-item indicators

Principle of compatibility states that "measures of behavior need to be formulated at the exact same level of specificity with regard to action, target, context, and time", and need to be taken into consideration when developing measures of behavior and TPB constructs. (I. Ajzen, 2002; Fishbein & Ajzen, 2005). The correlation between TPB constructs and the behavior they are supposed to predict will be the strongest when they are assessed at the same level of specificity with regard to the above four elements (Conner & Norman, 2005).

When developing the appropriate measures for TPB constructs it is common to begin with the conceptualization of the behavioral categories the study aims to predict. TPB measures are typically formulated using either 5- or 7- point scales, with multiple-item scales preferred over single-item measures because of increased reliability (Mark Conner & Norman, 2005; Glanz et al., 2008). However, single-item scales are used to assess the TPB constructs for their simplicity and ease of use as well as because they are less burdensome to study participants and may thus result in higher response rate (de Boer et al., 2004). From a practical point of view single-items offer advantages such as reduced cost and shorter survey length, they are easier to develop, administer, and adapt to different populations (Hoeppner, Kelly, Urbanoski, & Slaymaker, 2011). On the other, hand single items are criticized because their internal consistency cannot be assessed, their vulnerability to measurement errors, and biases in meaning and interpretation (Hoeppner et al., 2011).

Single item indicators have commonly and successfully been used to assess the self-rated health in many disciplines including epidemiology, health services, social science, and various

types of research (Agyemang, Denktas, Bruijnzeels, & Foets, 2006). Single item scales are typically used in different types of surveys assessing health related quality of life and have been found to perform well (Agyemang et al., 2006; Cunny & Perri, 1991; de Boer et al., 2004). Single item scales have also effectively been used to assess the motivation to stop smoking (Kotz, Brown, & West, 2013), predict smoking relapse (Berlin, Singleton, & Heishman, 2013), job satisfaction (Wanous, Reichers, & Hudy, 1997), academic anxiety (Gogol et al., 2014), and in various personality scales (Yarkoni, 2010).

Conclusions

Based on the review of literature, the TPB has been used to explain and successfully predict a variety of health behaviors, including SSB intake and PA. Majority of dietary and physical activity behavior TPB studies have found intentions to be the most predictive of behavior, with attitudes having the strongest influence on dietary intentions, and perceived behavioral control having the strongest influence on PA intentions (and behavior). However, the majority of the studies reviewed were cross-sectional in design, with fewer using the TPB longitudinally, and even fewer intervention studies. Most of the studies reviewed focused on the prediction of health-behavior intentions, with fewer focusing on the prediction of the actual behavior. There is also a gap in TPB literature when it comes to the utility of the TPB to assess attendance/participation and patterns of participation, which may be particularly useful in health behavior interventions (McEachan et al. 2011). Additionally, there is a clear gap in literature when it comes to the use of single-item indicators to assess TPB constructs in a study of dietary and physical activity behaviors. Understanding longitudinal patterns of change for TPB constructs and predictive models related to SSB and PA behaviors over time, may allow for further personalization and customization of supportive messages delivered through the IVR

system. Findings may also be used to inform future interventions aimed at improving health behaviors by targeting the TPB constructs.

Aims and Hypotheses

Aim 1: Determine if TPB single-item indictors are correlated with baseline TPB multi-item scales. We hypothesize that TPB single-item indicators will be highly correlated with the multi-item scales assessing the same construct for both SSB and PA.

Aim 2: Examine how baseline TPB variables predict participation in the SIPsmartER and MoveMore program. We hypothesize that baseline TPB variables will be predictive of participation in SIP*smartER* and MoveMore programs.

Aim 3: Determine how the TPB single-item indicators assessed during IVR calls predict future SSB and PA behaviors reported in a subsequent IVR call. We hypothesize that TBP variables will be predictive of behavior in the subsequent call for both SIP*smart*ER and MoveMore, with behavioral intentions being the strongest predictor of both behaviors.

Aim 4: Explore how SSB and PA TPB variables change over the course of the teach-back and 11 IVR calls. We hypothesize that both TPB single-item indicators related to both SSB and PA behaviors will show the trend of improvement over time.

Chapter 2

METHODS

Study Design and Intervention Structure

This research was a secondary data analysis of a larger six-month, two-arm, matched-contact randomized control trial, Talking Health (Zoellner et al., 2014). The primary aim of the Talking Health trial is to determine the effectiveness of a health behavior intervention on reducing sugar-sweetened beverage intake (SIP*smart*ER) as compared to a matched comparison group targeting physical activity behavior (MoveMore). The theoretical framework of the trial is based on health literacy (Berkman, Davis, & McCormack, 2010; National Research Council, 2004) and the Theory of Planned Behavior constructs (Zoellner et al., 2014).

Both groups participated in three small group educational classes, received one teach-back call, and completed eleven interactive voice response (IVR) phone calls during the six-month intervention phase. Process data related to self-reported behaviors and TPB constructs was collected at each of these points. During classes participants completed personalized action plans, which included setting behavioral goals and identifying barriers and strategies for overcoming them. Behavioral diaries were also provided to participants and they were encouraged to record their behavior (ounces of SSB and minutes of PA) daily, since this is the information reported to the IVR (Zoellner et al., 2014).

The purpose of the IVR calls were to reinforce key intervention messages, deliver brief theory-based messages, provide new content, and guide participants through behavior tracking and the action planning process. Participants received eleven IVR calls weekly for the first three weeks, and bi-weekly for the remainder of the intervention. At the beginning of each call, participants were prompted to enter their behavior from the previous week that they have

recorded in their behavioral diaries (ounces of SSB for SIP*smart*ER or minutes of PA for MoveMore condition). Based on their progress, participants were routed in one of the three paths: 1) meeting or exceeding goals, 2) not meeting goals, but some progress, 3) no progress. Behavioral reinforcement strategies based on the TPB are customized for each path and were intended to increase behavioral intentions and bolster perceptions of behavioral control (Zoellner et al., 2014). The action planning process guided participants in setting new realistic goals for the upcoming weeks, and identifying the barriers and strategies to overcome them. IVR calls three to eleven were concluded with supportive messages that were based on the TPB constructs, health literacy concepts, and upcoming classes. The length of IVR calls varied depending on the duration of barriers and strategies identification, but the estimated time ranged five to ten minutes per call.

The present research utilizes data from the baseline health assessment, IVR calls, class attendance and IVR and teach-back calls completion data. The Institutional Review Board (IRB) at Virginia Tech approved the study, and all participants gave written informed consent prior to participation. Gift cards in the amounts of $25 and $50 and were given at each of the two health screenings, respectively, as a compensation for the participants' time.

Target Population, Eligibility and Recruitment

Target Population

The Talking Health trial targeted residents from eight rural southwest Virginia counties including Lee, Giles, Pulaski, Washington, Grayson, Wise, Wythe, and Montgomery counties. According to the US Census Bureau data, most of the residents in these counties are White (94.6%), 18% of residents live below poverty line, and the educational attainment is low with 58% having received a high-school diploma or less (US Census Bureau, 2013).

Eligibility

To be eligible to participate in the study, individuals needed to be fluent in English, be 18 years old or older, and have no contraindications for moderate-intensity physical activity [assessed with adapted Physical Activity Readiness Questionnaire (Thomas, Reading, & Shephard, 1992)]. Additionally, participants needed to report the consumption of at least 200 kilocalories from SSBs per day [assessed with 15-item beverage questionnaire (BEVQ-15) (Valisa E. Hedrick et al., 2012)] and have reliable access to telephone. A screening questionnaire used to determine the eligibility, included questions concerning SSB intake (V. E. Hedrick et al., 2012), physical activity levels and limitations (Kiernan et al., 2013), health literacy (Fagerlin et al., 2007; Zikmund-Fisher, Smith, Ubel, & Fagerlin, 2007) and demographic data (US Census Bureau, 2013).

Recruitment

Several recruitment strategies were used to reach the target population including flyers, newspaper and radio advertisements, targeted postcard mailings, and word of mouth. Virginia Cooperative Extension agents were also hired in several of the counties to help with the recruitment efforts, and research assistants actively recruited participants in different locations within the community including libraries, community colleges, free health clinics, churches, health fairs, childcare centers, and festivals. A rolling enrollment approach was used, with additional cohorts being recruited and enrolled while the intervention for the earlier cohorts was ongoing (Zoellner et al., 2014).

Measures and Data Collection

Data was collected at baseline and during the teach-back and IVR calls. For the purpose of this research, baseline TPB variables assessed at initial health screening, teach-back call, and

IVR calls were used. Data related to behavior (reported fluid ounces of SSB and minutes of PA) collected at teach-back and each of the 11 IVR calls was also utilized. To ensure standardization and consistency, a data collection manual of procedures was developed and all research staff were trained prior to data collection.

Baseline Theory of Planned Behavior Variables

A computer-administered questionnaire was developed for Talking Health to assess behavioral, psychosocial, media literacy, and quality of life variables. This assessment included a validated instrument to assess the following TPB constructs for both SSB and PA behaviors: affective attitudes, instrumental attitudes, subjective norms, perceived behavioral control,, behavioral intentions, and implementation intentions (Rhodes & Courneya, 2003; Zoellner, Estabrooks, et al., 2012; Zoellner, Krzeski, et al., 2012). Responses to questions on this instrument were on a 7-point Likert scale. There were two distinct modules, one for SSB and one for PA,, that each consisted of 20 questions. Of these questions, there were six attitude questions (three questions about instrumental attitudes and three questions about affective attitudes); three subjective norms questions; three perceived behavioral control questions; four behavioral intention questions; and four implementation intention questions. The order of assessment completion was randomized where TPB assessments could be completed first with behavioral assessments last or vice versa (Zoellner et al., 2014).

IVR Theory of Planned Behavior Variables

Each IVR call assessed five TPB constructs: behavioral intentions, instrumental attitudes, affective attitudes, subjective norms, and perceived behavioral control. Participants' intentions were collected in the form of reported goal behavior (ounces of SSB or minutes of PA). Only one question (the single-item indicator), measured on a 7-point Likert scale, was used to assess

instrumental attitudes, affective attitudes, subjective norms, and perceived behavioral control with the IVR calls. Single-item indicators for these TPB variables were selected from the multi-item scales used at baseline data collection.

IVR Behavior

Over the course of the intervention, participants used behavioral diaries to daily record ounces of SSB intake and minutes of PA. Physical activity was reported as total minutes PA, times per week individuals engaged in cardio activity and average minutes, and times per week individuals engaged in strength activity and average minutes. During each IVR call participants were asked to report their daily average of SSB intake and weekly average of PA minutes.

Participation

Participation was measured as the number of the fifteen intervention activities completed by the participant: three classes, one teach-back call, and eleven IVR calls.

Data Analysis

All statistical tests were completed using SPSS version 22 (SPSS, Inc, Chicago, Illinois), and included Chi square tests, independent t-tests, Cronbach's alpha, Pearson's correlations, sequential multiple regression models, and descriptive statistics. Data was imputed using the multiple imputations method to account for missing data.

Demographic analysis

Chi square tests were used to compare categorical demographic variables between the groups (gender, race, health literacy level, education, income, and health insurance), and independent t-test was used for continuous variables (age).

Aim 1: Correlations between the single-item indicator and the multi-item scales

Pearson's correlations were used to explore the relationship between the TPB single-item indicator at baseline used in IVR calls and the TPB multi-item scale used to assess the same construct at baseline. During baseline health screening, each TPB construct (behavioral and implementation intentions, instrumental and affective attitudes, subjective norms, and perceived behavioral control) was measured on the 7-point Likert scale using a multi-item scale consisting of three to six questions. A single-item indicator was selected to assess the four TPB constructs (instrumental attitudes, affective attitudes, subjective norms, and perceived behavioral control) in the IVR calls. Additionally, internal consistency of the multi-item scales for these four TPB constructs was determined using Cronbach's α. Cronbach's α interpretation was based on the following cutoffs: >0.9 excellent, >0.8 good, >0.7 acceptable, >0.6 questionable, >0.5 poor and <0.5 unacceptable (Gliem & Gliem, 2003).

Aim 2: Prediction of participation from the TPB constructs at baseline

The relationship between TPB constructs assessed at baseline (multi-item scales of behavioral and implementation intentions, instrumental and affective attitudes, subjective norms, and perceived behavioral control) and participation in SIP*smart*ER and MoveMore was investigated using sequential multi-step regression models. Step one of the multi-step regression model assessed implementation intentions, step two – behavioral intentions, step three – perceived behavioral control and step four - subjective norms and attitudes. Participation was assessed as the proportion of the fifteen possible intervention activities completed by the participant. Significance was set at $P < 0.05$.

Aim 3: Prediction of behavior reported in IVR call from single-item indicators assessed at the previous call

A sequential multi-step regression model was utilized to explore the ability of the single-item indicators assessed at teach-back and IVR calls to predict the behavior at the subsequent call. There were nine total models per condition. TPB single-item indicators were treated as the independent variable, and the reported behavior (ounces of SSB or minutes of PA) from each subsequent call was treated as the dependent variable. Step one of the regression model included behavioral intentions, in step two, perceived behavioral control was added, and in the final step the instrumental attitudes were added, followed by affective attitudes, and subjective norms. The behavioral intention variable was conceptualized as the reported goal behavior for both SSB and PA. SIP*smart*ER and MoveMore conditions were examined separately. Significance was set at $P < 0.05$ levels.

Aim 4: Changes in single-item indicator responses from teach-back to IVR call 11

Descriptive statistics (mean ± standard deviation) and paired t-tests were used to examine the changes in single item indicators by conditions for teach-back and all11 IVR calls. For the purpose of this descriptive analysis, mean values for SIP*smart*ER and MoveMore group were examined separately. Mean differences from teach-back call relative to each of the 11 IVR calls were reported in the form of bar graph.

Chapter 3

RESULTS

Participants

A total of 1,056 individuals were screened, 620 (59%) were eligible, and 301 (30%) were enrolled in the trial. Of the 301 participants enrolled, 155 were randomized to Sip*Smart*ER and 146 to MoveMore at baseline health screenings *(Table 3.7)*. The majority of participants were female (81.1%) and Caucasian (93%), with a mean age of 48.83 ± 13.45. Additionally, 31.9% of participants completed less than or equal to high school education, 55.1% earned less than $20,000 per year, and 31.6% had a full time or part time job, with 21.9% being unemployed. Most participants reported having some form of health insurance (65.4%), and 32.9% were classified as low health literate (according to Newest Vital Sign scoring protocol).

When compared to US Census data, males and participants with less than a high school education were underrepresented, while low-income participants were overrepresented. Race was representative of the area (US Census Bureau, 2013). There were no significant demographic differences between Sip*Smart*ER and MoveMore participants.

Aim 1: Correlations between single-item indicators and multi-item scales at baseline *(Table 3.8a and Table 3.8b)*

SSB specific scales *(Table 3.8a)*

For SSB questions, the 3-item instrumental attitudes scale had a good internal consistency (α = 0.81), while the 3-item affective attitudes scale had acceptable internal consistency (α = 0.74). The 6-item total attitudes scale, 3-item subjective norms scale, and 3-item perceived behavioral control scale were found to have questionable internal consistency (Cronbach's α of 0.70, 0.62, and 0.68, respectively) *(Table 3.8a)*.

SSB-specific baseline single-item indicators selected to assess the four TPB variables during IVR calls were highly correlated ($r > 0.60$; $p < 0.001$) with the multi-item scales used to assess the same variables. Pearson's correlation revealed the highest correlation between the single-item indicator for the instrumental attitudes and its multi-item scale ($r = 0.88$; $p < 0.001$). The lowest, but still highly significant ($p < 0.001$) correlation was found between the single-item indicator for affective attitudes and its multi-item scale ($r = 0.60$; $p < 0.001$) *(Table 3.8a).*

Physical activity specific scales *(Table 3.8b)*

For PA questions, the 6-item total attitudes scale and 3-item instrumental attitudes subscale were found to have good internal consistency ($\alpha = 0.81$ and $\alpha = 0.83$, respectively). The 3-item affective attitudes subscale, 3-item subjective norms scale, and 3-item perceived behavioral control scale had acceptable internal consistency (Chronbach's α of 0.80, 0.74, and 0.73, respectively) *(Table 3.8b)***.**

All PA-specific single-item indicators were highly correlated with the comparable multi-item scales ($r > 0.69$; $p < 0.001$). The highest correlation was found between the single-item indicator for affective attitude and multi-item scales for affective attitudes subscale ($r = 0.88$; $p < 0.001$) and total attitudes scale ($r = 0.88$; $p < 0.001$). The lowest, but still highly significant correlation was found between the single-item indicator for instrumental attitudes and total attitudes multi-item scale ($r = 0.69$) *(Table 3.8b).*

Aim 2: Prediction of participation from the Theory of Planned Behavior variables at baseline *(Table 3.9a and Table 3.9b)*

TPB variables assessed at baseline health screenings (implementation intentions, behavioral intentions, perceived behavioral control, subjective norms, and attitudes) were not significant predictors of participation rates in either SIPsmartER or MoveMore. . Among

SIP*smart*ER participants, the final model (F=1.763, R^2=0.057, *P*=0.124) explained only 5.7 % of the variability in participation and was not found to be significant *(Table 3.9a)*. Similarly, for the MoveMore condition the final model (F=0.815, R^2=0.028, *P*=0.541) explained only 2.8% of the variance in participation and was not found to be significant *(Table 3.9b).*

Aim 3: Using the Theory of Planned Behavior variables to predict behavior reported in subsequent IVR call *(Table 3.10a and Table 3.10b)*

Tables 4a and 4b illustrate goal achievement percentages; average ounces of SSB goal and actual reported SSB; and F-statistics, R^2, and standardized beta-coefficients for the sequential multi-step regression models run to determine if responses to TPB variables during the previous call explained the SSB consumption in subsequent IVR call. *Table 4a* presents data for SIP*smart*ER participants while *Table 4b* presents data for MoveMore participants. Data related to goal achievement is only from those participants who completed the calls. Other data in the tables also includes the imputed data.

Predicting Reported SSB Behavior *(Table 3.10a)*

Each call had an approximately 50% completion rate (ranging from 47% to 57%). The majority of participants who completed the calls report achieving the goal, with the proportion of participants reporting goal achievement increasing over time (range from 56.4% at teach-back to 77.6% at IVR call 11) *(Table 3.10a).*

Regarding SSB-intake goals and reported ounces of SSB intake, both goals and reported intake decreased over time. At the teach-back, call the goal ounces and reported ounces were 21.57 and 35.48 ounces respectively, whereas at IVR call 11 these values were at 7.69 and 6.21 ounces.

Of the nine IVR regression models, eight were significant (TPB variables in IVR call 5 did not significantly predict SSB intake in IVR call 6). On average, these models explained 30% of variability in reported SSB intake (range from 6.8% to 61%). Interestingly, the addition of perceived behavioral control in Step 2 and instrumental attitudes, affective attitudes, and subjective norms in Step 3 did not significantly contribute to the R^2 in any of the models *(Table 3.10a).*

Behavioral intentions were the only consistent significant predictor of SSB intake. Standardized beta-coefficients for behavioral intentions in the final model were significant in all models. These coefficients indicated a positive relationship between intentions to consume certain amount of SSB (goal) and reported SSB intake (i.e., as the goal ounces increased, so did the actual intake).

Standardized β coefficients for other TPB variables indicate that they were not consistently significant in predicting the SSB intake. For example β coefficients for perceived behavioral control were significant in only three out of nine models. However, the association between perceived behavioral control and SSB intake was negative in eight out of nine models (i.e., as the perceived control over the behavior increased, the SSB intake decreased). β coefficients for subjective norms were significant in two out of nine models, with the association between subjective norms and SSB intake being negative for seven out nine of the models (as the perception of support from referent others increases, the SSB intake decreases). There was no consistency in the direction of association between instrumental and affective attitudes and SSB intake as approximately half of the calls showed positive association between instrumental and affective attitudes and SSB intake, while the other half showed negative association *(Table 3.10a).*

As an example interpretation, Step 3 of the analysis of TPB model in predicting SSB intake at IVR call 1, shows that the standardized β coefficients for behavioral intentions, instrumental attitudes, and affective attitudes significantly contributed to the model. Behavioral intentions had a standardized β coefficient of 0.381, which means that the standard deviation of the dependent variable (SSB ounces) increased by 0.381 when the independent variable (behavioral intentions) increased by one standard deviation. Increase in instrumental attitudes by one standard deviation lead to decrease in standard deviation of dependent variable (SSB intake) by 0.177, while one standard deviation increase in affective attitudes led to increase in dependent variable by 0.193. In the same example, behavioral intentions explained 10.5% of the variance in the behavior. Addition of perceived behavioral control to the model in Step 2 added only 1.1% to the explanation, and addition of instrumental attitudes, affective attitudes and subjective norms in Step 3 provided an additional 5% to the explanation of the SSB intake. TPB model from teach-back explained 16.4% of the variance in SSB intake in IVR call 1 *(Table 3.10a).*

Predicting Reported PA Behavior *(Table 3.10b)*

Each call had an approximately 50% completion rate (ranging from 42% to 52%). The majority of MoveMore participants who completed the call reported achieving the goal (range from 36.5% in IVR call 8 to 51.6% in IVR call 11). Overall, the percentage of participants achieving the goal increased over time (with 44.4% completing the teach-back call, and 51.5% completing the IVR call 11). Both average minutes of actual PA and goal minutes of PA increased over time (from 160.70 minutes at teach-back to 199.46 minutes at IVR call 11, and from 163.45 minutes at teach-back to 220.42 at IVR call 11, respectively) *(Table 3.10b).*

All nine regression models illustrating the ability of previously assessed TPB variables to predict PA in future IVR call were significant, explaining the average of 20% of the variance in

the behavior (range from 7.6% to 48.9%). Comparable to SSB behavior, the addition of other TPB variables (perceived behavioral control in Step 2 and instrumental attitudes, affective attitudes, and subjective norms in Step 3) did not significantly contribute to the explanation of the PA behavior *(Table 3.10b)*

Behavioral intentions were the only consistently significant predictor of PA (standardized β coefficients in the final model were significant in all models). β coefficients suggested a positive relationship between the goal (intentions) and reported minutes of PA (i.e., as the goal minutes increased so did the actual reported minutes).

β coefficient for perceived behavioral control was significant in only one out of nine models. However, as expected, the association between perceived behavioral control and PA was positive in eight out of nine models (when perceived behavioral control increased, so did the PA minutes) Surprisingly, the association between subjective norms and PA minutes was also negative in all except one model (as the perception of support from referent others increased, the minutes of PA decreased). β coefficient for subjective norms was significant in only one model. There was no consistency in the direction of association between instrumental and affective attitudes and PA behavior as approximately half of the calls showed positive association between instrumental and affective attitudes and PA minutes, while the other half showed negative association *(Table 3.10b)*.

As an example interpretation for PA, in Step 3 of the analysis of TPB model in teach-back predicting PA minutes at IVR call 1, shows that the standardized β coefficient for behavioral intentions was the only one that significantly contributed to the model. Behavioral intentions had a standardized β coefficient of 0.340, which means that the standard deviation of the dependent variable (PA minutes) increased by 0.340 when the independent variable

(behavioral intentions) increased by one standard deviation. Behavioral intentions explained 12.2% of the variance in the behavior in this model. However, perceived behavioral control in Step 2 added only 2.5% to the model, and the addition of instrumental attitudes, affective attitudes and subjective norms in Step 3 explained the additional 1.9% of the variance in behavior. TPB model as a whole (assessed at teach-back call) explained 16.4% of the variance in PA in IVR call 1 *(Table 3.10b).*

Aim 4: Changes in the Theory of Planned Behavior variable means over teach-back and IVR calls *(Table 3.11 and Figures 1a, 1b, 1c, and 1d***)**

SSB-specific Variables

Affective attitudes significantly increased from teach-back to IVR call 11 (p=0.032). Additionally, significant increases in affective attitudes occurred in IVR calls 8/9 ($p<0.001$) and significant decrease in IVR calls 10/11 (p=0.013).

Subjective norms significantly decreased from teach-back to IVR call 11 (p=0.001). Over the teach-back and 11 IVR calls, subjective norms significantly decreased in teach-back/IVR call 1 ($p<0.001$); IVR calls 5/6 (p=0.005); and IVR calls 7/8 (p=0.007) Increase in subjective norms was noted in IVR calls 6/ 7 (p=0.020) and IVR calls 10/11 ($p<0.021$).

Perceived behavioral control significantly increased from teach-back to IVR call 11 ($p<0.001$). Significant increase in perceived behavioral control between IVR calls was found in IVR calls 2/3 (p=0.048).

PA-specific Variables

For affective attitudes significant increase was found in IVR calls 8/9 ($p<0.001$); significant decrease in affective attitudes occurred in IVR calls 6/7 (p=0.041); and IVR calls IVR calls 9/10 (p=0.007).

Instrumental attitudes significantly decreased in IVR calls 3/4 (p=0.019] and IVR calls 9/10 (p=0.019). Instrumental attitudes significantly increased in IVR calls 8/9 (p<0.001).

Significant decrease in subjective norms was noted from the teach-back to IVR call 11 (p<0.001). Significant call-to-call decrease in subjective norms was found in teach-back/IVR call 1 (p<0.001); IVR calls 1/2 (p=0.006); and IVR calls 7/8, (p=0.002). Significant increase in subjective norms was found in IVR calls 8/9 (p=0.001). Significant increase in perceived behavioral control occurred in IVR calls 8/9 (p=0.018).

Changes in Theory of Planned Behavior Single-item Indicators Across Behaviors

A cluster of significant call-to-call changes in most of the TPB variables was noted for both groups in IVR calls 9, 10 and 11 (after class 3). Interestingly, while significant changes were noted in instrumental attitudes in IVR calls 8/9 for the MoveMore group, no significant changes in instrumental were exhibited in any of the calls for the SIP*smart*ER group. When comparing the two behaviors, affective attitudes and subjective norms were consistently higher for MoveMore group when compared to SIPsmartER, while there was no consistency in changes over time for instrumental attitudes and perceived behavioral control. Although significant changes were found between the two time points in several instances for both SSB and PA behavior, there were no notable patterns of change over time.

Chapter 4

DISCUSSION

A majority of TPB studies related to diet and physical activity are cross-sectional and longitudinal in design. The process of change in TPB variables over time and their relationship with the behavior at multiple time points have not previously been examined. The main objective of this research was to explore how TPB variables measured at teach-back and eleven IVR calls predict future behavior at subsequent call. Rather than focusing on how baseline TPB variables measured at baseline predict the future behavior, we looked into multiple time points across the six-month intervention. This research also provided a valuable insight into how the TPB variables change from one to the following time point (IVR call) and explored the relationship between these variables (significance and direction of call-to-call changes and the difference between initial and each subsequent call).

Single-item Indicators Can Be Used to Measure The Theory of Planned Behavior Variables

Our findings showed that single-item questions for both SSB and PA and their multi-item scales were highly correlated (> 0.60 and > 0.69 respectively). Single-item indicators have been commonly used as a health related quality of life measure (Agyemang et al., 2006; Cunny & Perri, 1991; de Boer et al., 2004). Multi-item scales are preferred and have typically been used to assess the TPB constructs due to better internal consistency (Hoeppner et al., 2011). However, based on our findings we can conclude that single-item questions selected to measure the TPB variables in IVR calls are representative of the multi-item scales. Additionally, internal consistency of multi-item scales was acceptable for the majority of the TPB variables, suggesting that this instrument was reliable.

Our findings, which suggest that only one question can be used to assess TPB variables, could have many practical applications. Using single question as opposed to multi-item scales would save time in the process of data collection and data analysis, would be easier to administer and be less burdensome to our participants.

The Theory of Planned Behavior Variables May Not Be Useful in Predicting Participation

Our findings do not show a significant relationship between baseline TPB variables and participation in the SIP*smart*ER or MoveMore program. Literature on the relationship between the TPB variables and participation is limited, since the model is primarily designed to predict intentions related to a behavior. Potential use of the TPB model to predict patterns and frequency of participation could be beneficial, since behavior repetition seems to be essential when it comes to sustainable health behavior change (Sheeran et al., 2001).

Strength of the TPB is in its ability to predict intentions to engage in the behavior and not necessarily behavior participation, which is the clear limitation. However, by further examining the relationship between intentions (and other TPB variables) at baseline and levels of participation, strategies could be developed that would be tailored towards initially reported underlying beliefs. Expanding the theory in this way could enhance its application in diet and PA interventions and potentially improve participation in programs.

Behavioral Intention Was The Only Consistently Significant Predictor of Behavior

Behavioral intentions assessed in IVR calls as the reported goal behavior (goal ounces of SSB/goal minutes of PA) were the only consistently significant predictor of the behavior in the subsequent call. The addition of other TBP variables provided substantially less variance in both behaviors. Unlike β coefficients for behavioral intentions, which were consistently significant, β coefficients for other TPB variables were predominantly non-significant. Our findings are

consistent with literature stating that behavioral intentions are the strongest predictor of the variance in health related behaviors (Armitage & Conner, 2001b; Godin & Kok, 1996a; McEachan et al., 2011). Compared to two studies of SSB intake among adolescents where behavioral intentions and perceived behavioral control combined explained 15% (Kassem et al., 2003) and 28% (Kassem & Lee, 2004), explanation provided by intentions alone (~30%) was higher in our model.

According to the literature, attitudes typically provide the highest variance in intentions followed by perceived behavioral control (Godin & Kok, 1996a). We found that β coefficients for SSB attitudes were significant in two out of nine models, and SSB-perceived behavioral control were significant in three out of nine models. Similarly, for PA β coefficients for attitudes were significant in three and for perceived behavioral control in only one out of nine models. However, it is important to note that we examined the relationship between these constructs and behavior, and not their relationship with intentions. Attitudes, subjective norms, and perceived behavioral control are conceptualized as predictors of intentions and not behavior directly within the TPB (with the exception of perceived behavioral control which affects both intentions, and behavior directly).

We found that the relationship between perceived behavioral control and SSB intake (negative relationship - as perceived control over the behavior increased – SSB intake decreased) and perceived behavioral control and PA (positive relationship - as perceived control over the behavior increased – PA levels increased) was consistently desirable, which is what we expected. However, subjective norms had negative association with both behaviors (as subjective norms increased, SSB intake decreased; and as subjective norms increased PA decreased). This inconsistency is possibly due to the different nature of the two behaviors.

Although behavioral intentions consistently provided significant explanation of SSB and PA behaviors, the addition of other TPB constructs still added to the explanation of both behaviors. The additional variance added by attitudes, subjective norms, and perceived behavioral control needs to be viewed in the context of the TPB model, where these constructs are conceptualized as predictors of intentions, and not behavior directly.

There are No Significant Patterns of Change in Between IVR Calls Over Time

Although significant changes in IVR TPB variables were found between the two time points in several instances for both SSB and PA behavior, there were no patterns of change over time. Despite the fact that attitudes, subjective norms, perceived behavioral control, and behavioral intentions were targeted in each class, no significant association between the constructed targeted and changes in these constructs in subsequent IVR call(s) was found. The exception could possibly be the cluster of changes in TPB variables that happened after the class three.

The directions in which TPB variables were changing from call-to-call were inconsistent (a significant decrease would often be followed by a significant increase in the same variable). This inconsistency is possibly due to the differences in the actual sample of participants that were completing each call. In order to have a clearer picture of these relationships and understand the pattern of change, we would need to follow the changes that occur over time for each participant individually.

Limitations

The major limitation we encountered was the completeness of the data, since only ~50% of Talking Health participants completed IVR calls. However, to account for missing data, multiple imputations were used.

We have examined the TPB means when describing the changes over time in Aim four, which inevitably skewed our results, as all the individual differences were lost. Additionally, we have only made comparisons from teach-back to final IVR call, and to the previous time point. These changes (and our findings) would have been different if multiple points of comparison were included. It should also be noted that our sample consist of primarily Caucasian females from rural Southwest Virginia, which limits the generalizability of our findings.

Future Directions

The unique theoretical framework of the Talking Health study based on both health literacy and the TPB concepts offered a valuable background for exploring the usefulness and practical application of these concepts among our population (low-income, low health-literate residents of the Appalachia region).

When simplified, our findings can be summarized in a few major points: 1) a single TPB question can be used to assess the TPB variables; 2) it may be beneficial to address TPB variables at baseline differently based on participants' responses and tailor messages that would help increase the participation; 3) behavioral intention is the most significant predictor of the behavior; 4) there are no significant patterns of change in TPB single-item indicators over teach back and 11 IVR calls.

Based on these findings, future interventions would benefit from assessing the behavioral intentions at multiple time points (such as IVR calls in Talking Health) in the form of behavioral goal setting. The next step is to determine the variance in SSB and PA intentions provided by attitudes, subjective norms, and perceived behavioral control. Although supportive messages based on theory are beneficial (even though not consistently significant, these constructs do contribute to the variance in behavior), we do not see much variability over time. Based on these

future findings, IVR content related to TPB constructs could be customized by emphasizing the constructs that have the strongest impact on each behavior at different time points.

Conclusions and Implications

We have found that our single-item indicators function as a reliable instrument for measuring the TPB variables in IVR calls, with multi-item scales showing satisfactory internal consistency. Behavioral intentions were found to be the most significant predictor of the behavior in IVR calls, and no significant patterns of change were noted in call-to-call exploration of the TPB variable means over teach-back and IVR calls. Baseline TPB variables did not significantly predict participation in the program. This leads us to conclude that single-item questions assessing TPB constructs may be the most pragmatic way to utilize the TPB in future interventions targeting health behaviors, especially when systems such as IVR are used. Behavioral intentions assessed in the form of the goal behavior are the best way to predict the behavior. However, further research is needed to assess the variability in behavioral intentions provided by attitudes, subjective norms, and perceived behavioral control.

Table 3.7. Demographic characteristics of participants at baseline (n = 301)

Demographic Characteristics	**All** (n = 301)	**Sip*Smart*ER** (n = 155)	**MoveMore** (n = 146)	**Statistic*** (p-value)
Mean age (SD)	48.83 (13.38)	41.44 (13.45)	42.24 (13.34)	-0.52 (0.60)
Gender n (%)				
Male	57 (18.9%)	29 (18.7%)	28 (19.2%)	0.01 (1.00)
Female	244 (81.1%)	126 (81.3%)	118 (80.8%)	
Race n (%)				
Caucasian	280 (93%)	141 (91%)	139 (95.2%)	2.08 (0.18)
Other	21 (7%)	14 (9%)	7 (4.8%)	
Education n (%)				
≤ High school	96 (31.9%)	52 (33.5%)	44 (30.1%)	0.40 (0.54)
> High school	205 (68.1%)	103 (66.5%)	102 (69.9%)	
Income n (%)				
< $20,000	166 (55.1%)	90 (58.1%)	76 (52.1%)	1.10 (0.30)
≥ $20,000	135 (44.9%)	65 (41.9%)	70 (47.9%)	
Employment n (%)				
Full/part time	95 (31.6%)	46 (29.7%)	49 (33.6%)	0.91 (0.64)
Other	140 (46.6%)	72 (46.5%)	68 (46.6%)	
None	66 (21.9%)	37 (23.9%)	29 (19.9%)	
Insurance n (%)				
Insured	197 (65.4%)	98 (63.2%)	99 (67.8%)	0.70 (0.47)
Uninsured	104 (34.6%)	57 (36.8%)	57 (36.8%)	
Health Literacy n (%)				
Low	99 (32.9%)	53 (34.2%)	46 (31.5%)	0.25 (0.63)
High	202 (67.1%)	102 (65.8%)	100 (68.5%)	

*Test statistic and p-value for either Independent t-test or X^2 test to determine if differences exist based on condition

Table 3.8a. Correlations between SSB-TPB single-item indicators and multi-item scales

Single Item Indicator	**TPB Question**	**Multi-item Scale** (# questions)	**Cronbach's α**	**Pearson's Correlation (Sig.)**
Affective Attitudes	*For you, drinking less than 1 cup of sugary drinks each day would be enjoyable/unenjoyable*	Affective Attitudes Subscale (n=3)	0.74	0.87** (<0.001)
		Attitudes Total Scale (n=6)	0.70	0.60** (<0.001)
Instrumental Attitudes	*For you, drinking less than 1 cup of sugary drinks each day would be healthy/unhealthy*	Instrumental Attitudes Subscale (n=3)	0.81	0.88** (<0.001)
		Attitudes Total Scale (n=6)	0.70	0.71** (<0.001)
Subjective Norms	*Most people who are important to you want you to drink less than 1 cup of sugary drinks each day agree/disagree*	Subjective Norms (n=3)	0.62	0.81** (<0.001)
Perceived Behavioral Control	*Limiting your sugary drinks to less than 1 cup of sugary drinks each day if you wanted to do so would be easy/difficult*	Perceived Behavioral Control (n=3)	0.68	0.78** (<0.001)

**Correlations between the SSB-TPB single item indicators and multi-item scales are found to be significant (r > 0.60) for all SSB-TPB variables
Cronbach's alpha ranges: > 0.9 – Excellent, **> 0.8 – Good**, **> 0.7 – Acceptable**, **> 0.6 – Questionable**, > 0.5 – Poor, and < 0.5 – Unacceptable, (George & Mallery, 2003)

Table 3.8b. Correlations between PA-TPB single-item indicators and multi-item scales

Single Item Indicator	**TPB Question**	**Multi-item Scale** (# of questions)	**Cronbach's α**	**Pearson's Correlation (Sig.)**
Affective Attitudes	*For you, moderate-intensity physical activity over the next 1 month would be enjoyable/unenjoyable*	Affective Attitudes Subscale (n=3)	0.80	0.88** (<0.001)
		Attitudes Total Scale (n=6)	0.81	0.88** (<0.001)
Instrumental Attitudes	*For you, moderate-intensity physical activity over the next 1 month would be healthy/unhealthy*	Instrumental Attitudes Subscale (n=3)	0.83	0.84** (<0.001)
		Attitudes Total Scale (n=6)	0.81	(<0.001)
Subjective Norms	*Most people who are important to you want you to engage in moderate-intensity physical activity over the next 1 month agree/disagree*	Subjective Norms (n=3)	0.74	0.83** (<0.001)
Perceived Behavioral Control	*Engaging in moderate-intensity physical activity over the next 1 month if you wanted to do so would be easy/difficult*	Perceived Behavioral Control (n=3)	0.73	0.75** (<0.001)

**Correlations between the PA-TPB single item indicators and multi-item scales are found to be significant (r > 0.69) for all PA-TPB variables

Cronbach's alpha ranges: > 0.9 – Excellent, **> 0.8 – Good**, **> 0.7 – Acceptable**, > 0.6 – Questionable, > 0.5 – Poor, and < 0.5 – Unacceptable, (George & Mallery, 2003)

Table 3.9a. Sip*smart*ER: Prediction of participation (teach back call, 11 IVR calls, and 3 classes) from TPB variables at baseline

Predictor Variable (n=153)	**F**	**R^2**	**Standardized Coefficients in Final Model**
Step 1: Implementation Intentions	3.793	0.025	-0.184
Step 2: Behavioral intentions	2.043	0.027	0.071
Step 3: Perceived behavioral control	1.777	0.035	0.109
Step 4: Subjective norms	1.763	0.057	-0.096
Step 4: Attitudes	1.763	0.057	-0.115

^ $R^2\Delta < 0.05$ *P < 0.05; **P < 0.01
IVR – Interactive voice response; TPB – Theory of Planned Behavior

Table 3.9b. MoveMore: Prediction of participation (teach back call, 11 IVR calls, and 3 classes) from TPB variables at baseline

Predictor Variable (n=145)	**F**	**R^2**	**Standardized Coefficients in Final Model**
Step 1: Implementation Intentions	0.129	0.001	0.057
Step 2: Behavioral intentions	0.992	0.014	-0223
Step 3: Perceived behavioral control	1.314	0.027	0.119
Step 4: Subjective norms	0.815	0.028	-0.005
Step 4: Attitudes	0.815	0.028	0.049

^ $R^2\Delta < 0.05$ *P < 0.05; **P < 0.01
IVR – Interactive voice response; TPB – Theory of Planned Behavior

Table 3.10a: Prediction of reported SSB intake in following IVR call from the TPB variables

Call	TB to IVR1	IVR 1 to IVR 2	IVR 2 to IVR 3	IVR 4 to IVR 5	IVR 5 to IVR 6	IVR 6 to IVR 7	IVR 7 to IVR 8	IVR 9 to IVR 10	IVR 10 to IVR 11
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Completing the call	78	87	87	85	83	89	85	74	76
Achieved goal	56.4% (44)	64% (56)	63.2% (55)	70.6% (60)	69.9% (58)	74.2% (66)	72.9% (62)	75.7% (56)	77.6% (59)
Made some progress	19.2% (15)	6.9% (7)	10.3% (9)	8.2% (7)	9.6% (8)	4.5% (4)	7.1% (6)	5.4% (4)	1.3% (1)
Did not make progress	24.4% (19)	28.7% (25)	26.4% (23)	21.2% (18)	20.5% (17)	21.3% (19)	20% (17)	18.9% (14)	21.1% (16)
Total n	155	155	155	155	155	155	155	155	155
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Average Ounces of Goal Set	21.57 (19.56)	24.64 (33.04)	23.31 (48.52)	12.43 (10.70)	9.72 (10.78)	9.43 (10.03)	9.47 (8.07)	8.65 (13.40)	6.21 (6.10)
Average Ounces Reported	35.48 (56.12)	30.46 (70.91)	20.03 (18.63)	12.70 (16.38)	12.03 (13.10)	11.925 (10.97)	10.00 (8.71)	7.09 (8.04)	7.69 (9.20)
	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)
Step 1 Model	17.96*** (0.105)	176.17*** (0.535)	52.42*** (0.255)	19.84*** (0.115)	7.71** (0.048)	77.72*** (0.337)	183.76*** (0.546)	18.41*** (0.107)	177.84*** (0.538)
Step 2 Model	9.98*** (0.116)	87.91*** (0.536)	27.52*** (0.266)	11.26** (0.129)	4.45* (0.058)	38.74*** (0.338)	95.43*** (0.557)	31.22*** (0.291)	94.34*** (0.554)
Step 3 Model	5.93*** (0.166)	37.50*** (0.557)	11.06*** (0.271)	4.58** (0.130)	2.16 (0.068)	20.01*** (0.402)	38.18*** (0.562)	15.61*** (0.344)	46.55*** (0.610)
	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3
Step 1: Behavioral Intentions	0.381***	0.757***	0.502***	0.269**	0.172*	0.479***	0.706***	0.186*	0.650***
Step 2: PBC	0.006	-0.027	-0.074	-0.129	-0.110	-0.046	-0.146*	-0.526***	-0.308***
Step 3: Instrumental Attitudes	-0.177*	-0.004	-0.021	0.032	0.115	-0.229**	0.013	0.155*	-0.077
Step 3: Affective Attitudes	0.193*	0.145*	-0.069	-0.011	-0.048	0.012	0.083	0.127	0.298***
Step 3: Subjective Norms	0.095	-0.112*	-0.052	-0.002	0.070	-0.098	-0.024	-0.145*	-0.036

*p <0.05 ** p <0.01 *** p <0.001 ^$R^2\Delta$ <0.05

Table 3.10b: Prediction of reported total minutes of physical activity in following IVR call from TPB variables

Call	TB to IVR1	IVR 1 to IVR 2	IVR 2 to IVR 3	IVR 4 to IVR 5	IVR 5 to IVR 6	IVR 6 to IVR 7	IVR 7 to IVR 8	IVR 9 to IVR 10	IVR 10 to IVR 11
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Completing the call	81	66	77	72	78	74	66	62	62
Achieved goal	44.4% (36)	50.0% (33)	36.4% (28)	41.7% (30	46.2% (36)	48.6% (36)	36.4% (24)	43.5% (27)	51.6% (32)
Made some progress	21% (17)	24.2% (16)	15.6% (12)	12.5% (9)	7.7% (6)	13.5% (10)	10.6% (7)	9.7% (6)	11.3% (7)
Did not make progress	34.6% (28)	25.8% (17)	48.1% (37)	45.8% (33)	46.2% (36)	37.8% (28)	53% (35)	46.8% (29)	37.1% (23)
Total n	146	146	146	146	146	146	146	146	146
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Average Minutes Goal Set	163.45 (78.11)	203.48 (129.91)	270.49 (187.82)	249.61 (165.85)	294.98 (254.41)	306.17 (337.33)	228.73 (118.73)	386.31 (335.85)	220.42 (111.06)
Average Minutes Reported	160.70 (131.67)	240.48 (197.57)	201.01 (179.76)	241.96 (225.88)	273.63 (345.36)	202.31 (131.36)	173.33 (96.97)	178.50 (99.78)	199.49 (120.54)
	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)	F-statistic (R^2)
Step 1 Model	20.07*** (0.122)	14.06*** (0.089)	122.90*** (0.460)	9.60** (0.062)	20.24*** (0.123)	12.31** (0.079)	33.64*** (0.189)	8.10** (0.053)	25.08*** (0.148)
Step 2 Model	12.31*** (0.147)	7.45** (0.309)	62.90*** (0.468)	5.05* (0.066)	10.06** (0.123)	6.21** (0.080)	19.56*** (0.215)	4.52* (0.059)	12.46*** (0.148)
Step 3 Model	5.50*** (0.164)	4.65** (0.142)	26.76*** (0.489)	2.29* (0.076)	4.46** (0.137)	3.72** (0.117)	12.73*** (0.313)	6.39*** (0.186)	6.50*** (0.188)
	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3	β Step 3
Step 1: Behavioral Intentions	0.340***	0.288***	9.734***	0.281**	0.346***	0.302***	0.433***	0.192*	0.328***
Step 2: PBC	0.123	0.046	1.630	0.003	0.039	0.043	0.168*	0.043	-0.122
Step 3: Instrumental Attitudes	0.086	-0.079	-1.978	-0.048	-0.021	-0.117	0.150*	0.035	0.005
Step 3: Affective Attitudes	0.076	0.144	-0.816	-0.081	-0.082	-0.094	0.208**	0.316***	0.233*
Step 3: Subjective Norms	-0.043	-0.171	0.209	-0.041	-0.090	-0.148	-0.213**	-0.163	-0.073

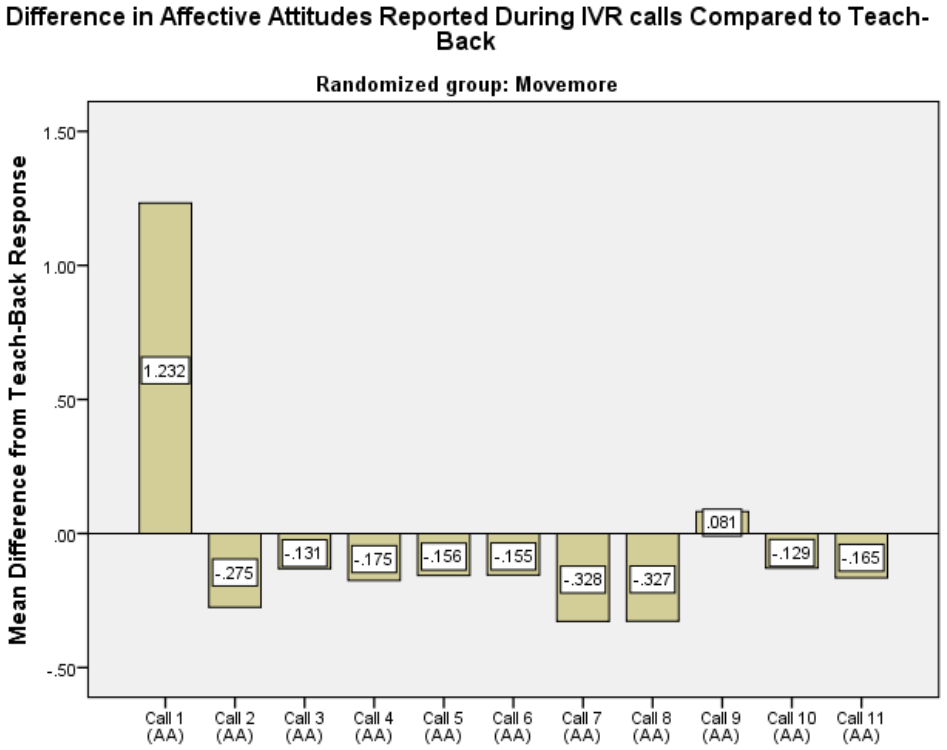
*p <0.05 ** p <0.01 *** p <0.001 $\hat{}R^2\Delta$ <0.05

Table 3.11. Changes in TPB single-item indicators from teach-back to IVR Call 11

Activity	TPB Constructs Targeted				Participant Responses Mean (SD)							
	A	SN	PBC	BI	AA *SIP*	AA *Move*	IA *SIP*	IA *Move*	SN *SIP*	SN *Move*	PBC *SIP*	PBC *Move*
Class 1	X	X	X	X	--	--	--	--	--	--	--	--
TB			X		4.60 (1.31)	5.23 (1.08)	6.36 (1.03)	6.32 (1.03)	5.83 (1.40)	6.22 (0.91)	4.43 (1.64)	4.61 (1.34)
IVR1			X	X	4.60 (0.09)	5.08 (0.09)	6.39 (0.06)	6.34 (0.06)	**5.23** (0.09)**	**5.61** (0.09)**	4.44 (0.10)	4.61 (0.10)
IVR2			X	X	4.64 (0.08)	4.95 (0.08)	6.37 (0.06)	6.37 (0.06)	5.15 (0.08)	**5.37* (0.09)**	4.36 (0.10)	4.49 (0.11)
IVR3			X	X	4.79 (0.09)	5.10 (0.09)	6.41 (0.06)	6.42 (0.06)	5.30 (0.09)	5.42 (0.09)	**4.60* (0.10)**	4.56 (0.11)
Class 2	X	X	X	X	--	--	--	--	--	--	--	--
IVR4			X	X	4.80 (0.09)	5.05 (0.09)	6.45 (0.06)	**6.28* (0.06)**	5.29 (0.07)	5.51 (0.07)	4.55 (0.11)	4.65 (0.11)
IVR5			X	X	4.81 (0.09)	5.07 (0.09)	6.28 (0.07)	6.33 (0.07)	5.25 (0.08)	5.44 (0.08)	4.58 (0.10)	4.52 (0.10)
IVR6	X		X	X	4.75 (0.09)	5.07 (0.09)	6.44 (0.06)	6.34 (0.06)	**4.95* (0.08)**	5.32 (0.08)	4.53 (0.10)	4.60 (0.11)
IVR7		X	X	X	4.86 (0.09)	4.90* (0.10)	6.36 (0.07)	6.25 (0.07)	**5.23* (0.08)**	5.41 (0.08)	4.66 (0.10)	4.49 (0.10)
IVR8			X	X	4.70 (0.09)	4.90 (0.09)	6.39 (0.06)	6.25 (0.06)	**4.99* (0.08)**	**5.19* (0.08)**	4.82 (0.11)	4.63 (0.11)
Class 3	X	X	X	X	--	--	--	--	--	--	--	--
IVR9			X	X	**5.11** (0.09)**	**5.31** (0.09)**	6.45 (0.05)	**6.48** (0.06)**	5.10 (0.07)	**5.44* (0.07**)	5.01 (0.09)	**4.88* (0.09)**
IVR10			X	X	4.98 (0.09)	**5.10* (0.09**)	6.41 (0.05)	**6.36* (0.06)**	5.25 (0.07)	5.37 (0.07)	5.09 (0.09)	4.85 (0.09)
IVR11			X	X	**4.89*+ (0.09)**	5.06 (0.09)	6.48 (0.05)	6.44 (0.05)	**5.41*^ (0.08)**	**5.49^ (0.08)**	**4.97^ (0.10)**	4.77 (0.10)

*p<0.05 difference from preceding time point**; p<0.001 difference from preceding time point
+p<0.05 difference from teach-back to IVR call 11; ^p<0.001 difference from teach-back to IVR call 11
A – attitudes; SN - subjective norms; PBC -; perceived behavioral control; BI – behavioral intentions; AA – affective attitudes; IA – instrumental attitudes

Figure 1a. Differences in affective attitudes from teach-back responses to each of the eleven IVR calls



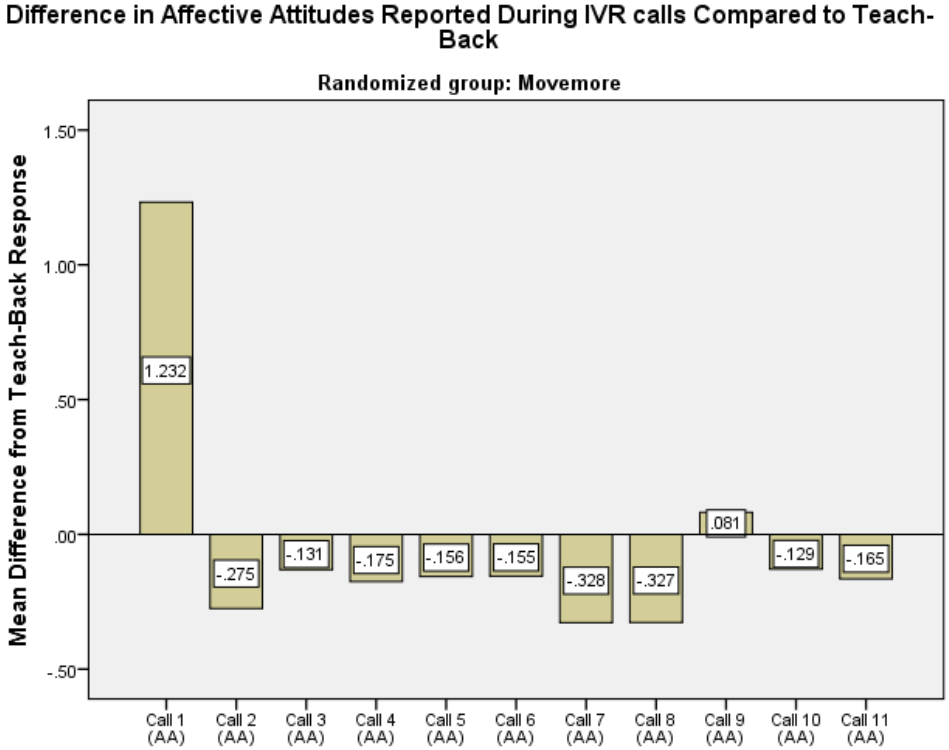
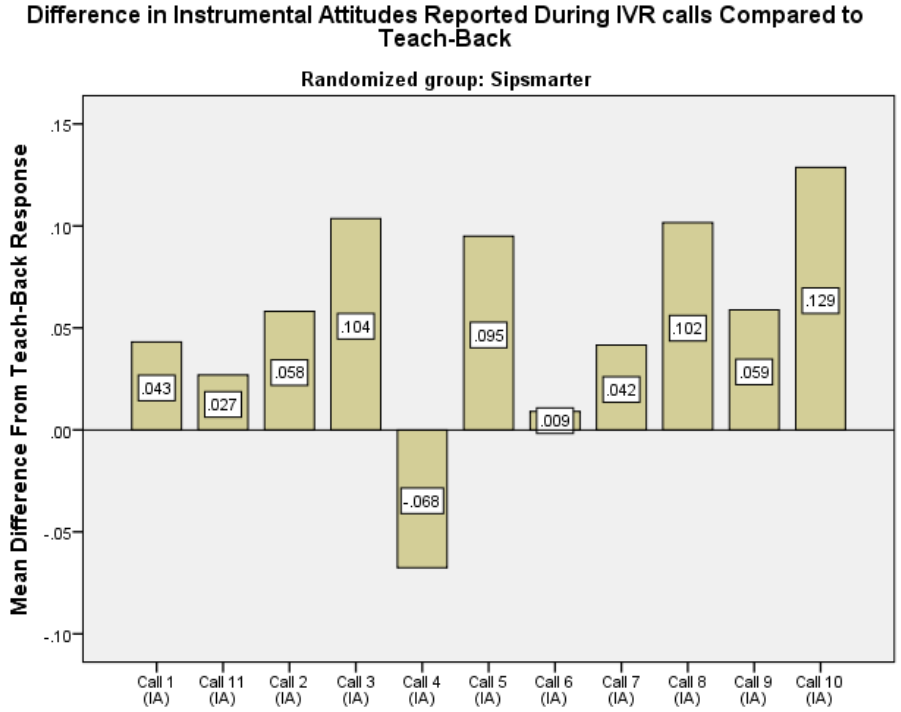


Figure 1b. Differences in instrumental attitudes from teach-back responses to each of the eleven IVR calls



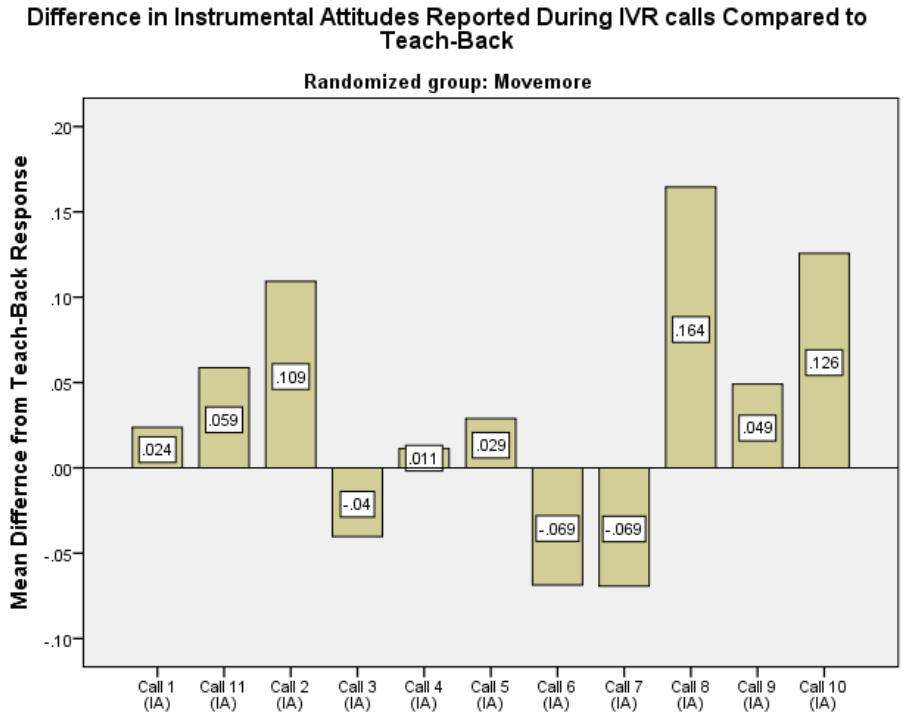


Figure 1c. Differences in subjective norms from teach-back responses to each of the eleven IVR calls

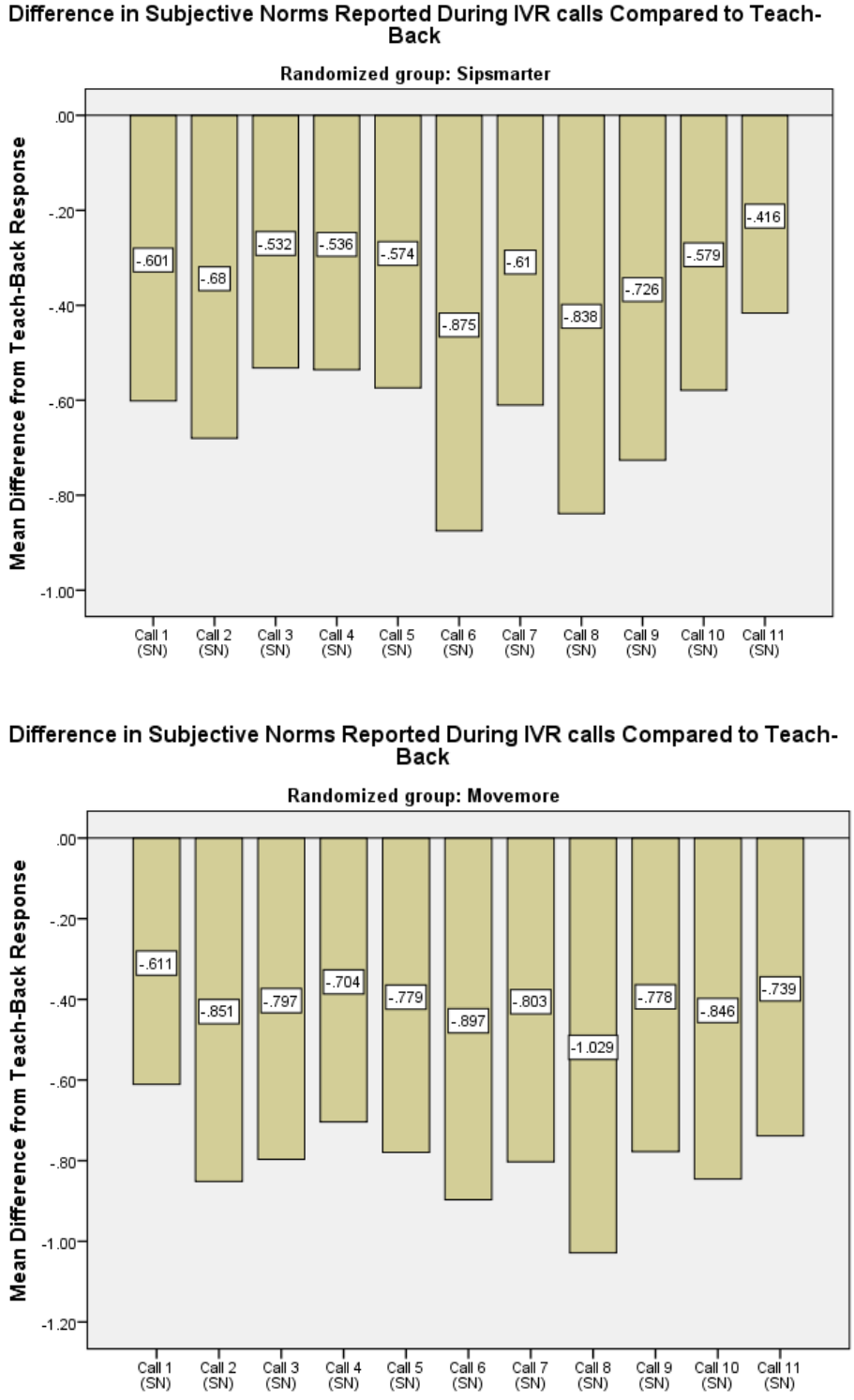
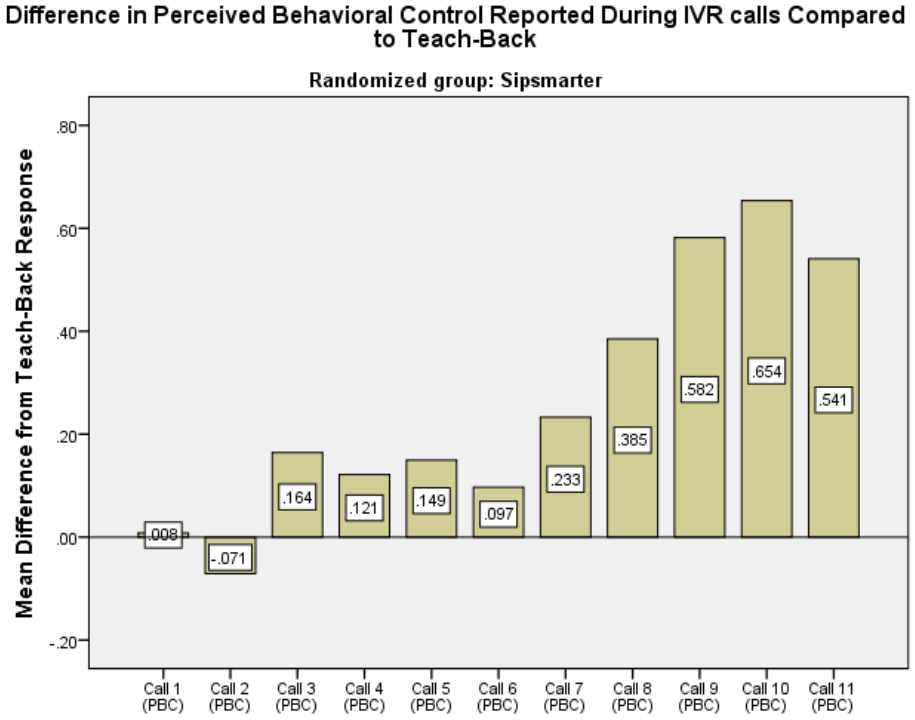
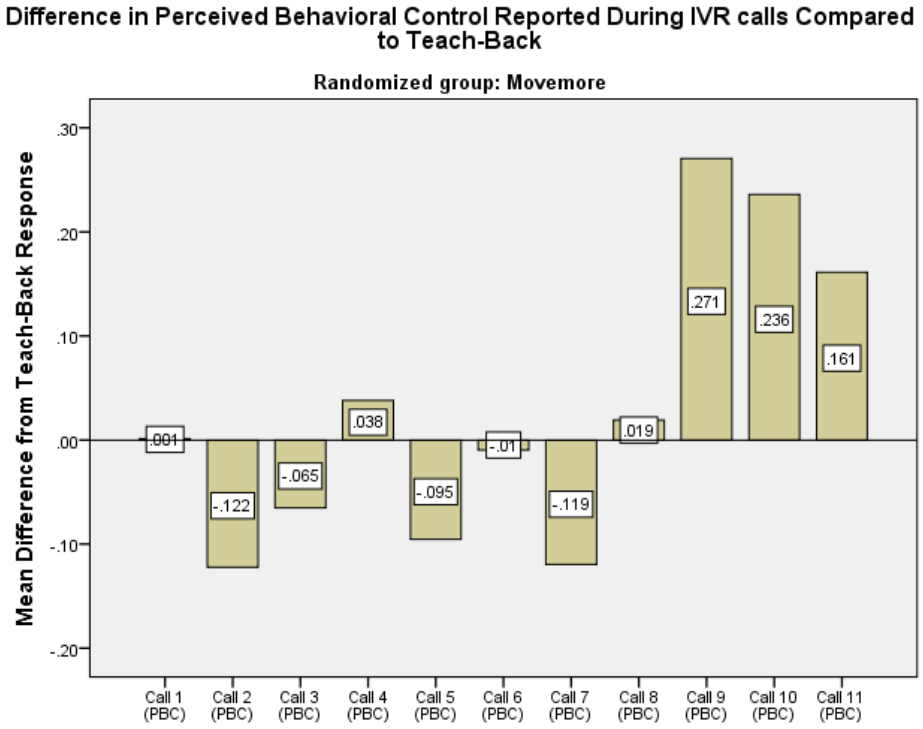


Figure 1d. Differences in perceived behavioral control from teach-back responses to each of the eleven IVR calls





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