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The Role of Executive Function on Weight Loss and Maintenance in a Couples-Based Intervention

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Weight loss is reliably achieved through standard behavioral programs, yet weight loss maintenance (WLM) has proven to be an elusive goal and is one of the field's most significant dilemmas. Given the complex and multifaceted nature of WLM, a specific subset of cognitive processes known as executive functions (EF) involved in high-order or top-down cognitive functioning, are likely among the most highly implicated neural systems in successful weight management. The complexity of weight loss maintenance is unlikely to exist solely due to individual-level factors, and likely involves the larger environmental context in which an individual is nested. This study examined the relationship between EF and environmental supports on weight loss and WLM in a 6-month couples-based behavioral weight loss intervention. It was hypothesized that 1) stronger executive functions would predict better weight loss and maintenance outcomes and 2) that executive skills would improve over the course of the intervention. Finally, potential environmental moderators of the relationship between EF and weight management were explored.

Cohabitating spousal dyads (N=64) were randomized to 24-weeks of standard behavioral weight loss (BWL) or behavioral weight loss plus support training, guided by Self-Determination Theory (SDT-WL). Participants were weighed at baseline, 6, and 12-months, completed EF measures at baseline and program completion (6-months), and measures of social and environmental support at baseline, 3, 6, and 12 months.

Several EFs, including processing speed and inhibition, predicted initial weight loss. Cognitive flexibility predicted weight loss and maintenance. Measures of EF improved from baseline to program completion, particularly self-reported EF. Finally, moderation analyses revealed mixed findings for interactions between baseline executive skills and environmental supports predicting weight loss and maintenance success, such that stronger executive skills and high support environments generally predicted greater weight loss.

Participants' baseline executive skills tended to predict weight loss and maintenance, however, many of these skills also improved during the intervention period, suggesting potential cognitive benefits inherent in standard behavioral weight loss interventions. Additionally, the combination of strong executive skills and high support environments, consistently predicted better weight outcomes. Future interventions might improve maintenance success by bolstering existing modules that promote improved executive abilities and social/environmental supports simultaneously.

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The Role of Executive Function on Weight Loss and Maintenance in a Couples-Based Intervention

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Rates of obesity continue to rise worldwide and remain among the most pressing healthcare and financial concerns in the United States (Finkelstein, Brown, Wrage, Allaire, & Hoerger, 2010; Fryar, Carroll, & Ogden, 2015; Ogden, Carroll, Kit, Flegal, 2012). The economic, medical, and social costs of overweight and obesity are well documented and projected to increase by $48-66 billion per year by 2030 (Finklestein et al., 2012; Wang et al., 2011). Obesity can be attributed to both individual-level factors that might account for variability in weight management among the general population (Anderson, Konz, Frederich, & Wood, 2001; Jansen, Houben, & Roefs, 2015), and to an increasingly "obesogenic" environment in which food is abundant and caloric expenditure is minimized by modern advances (Swinburn, Egger, & Raza, 1999). While behavioral weight loss programs have proven successful in engendering initial weight loss, recidivism is a central concern. Five years post-treatment, nearly 50% of participants regain to their baseline weight or beyond (Brownell & Jeffrey, 1987). Despite decades of research, mechanisms underlying successful weight loss maintenance (WLM) remain poorly understood and continue to elude the obesity field. The National Institutes of Health (NIH) have recognized the weight loss maintenance dilemma as a top research priority, specifically the need to look beyond the physical consequences of overweight and obesity and consider the neurocognitive underpinnings of maintenance success (MacLean et al., 2015).

Several promising and novel approaches at the individual and social-environmental level may help address the weight loss maintenance dilemma. At the individual level, there has been a call for increased focus on neuropsychological factors underlying successful weight loss maintenance, and greater integration of neurobiological, physiological, and psychological perspectives (Jansen et al., 2015). Indeed, adults with obesity are prone to experience deficits in inhibition, planning, decision-making, concept-formation, and set shifting, independent of associated medical conditions, education level, and general cognitive ability (Smith, Hay, Campbell, & Trollor, 2011). While most studies in this area are cross-sectional, longitudinal data also support associations between midlife obesity and future cognitive decline and dementia (Fitzpatrick, Kuller, Lopez et al., 2009; Gustafson, 2008; Guxens et al., 2009; Kivipelto, Ngandu, Fratiglioni et al., 2005; Whitmer et al., 2008). Significant gaps remain, as few studies have utilized comprehensive neuropsychological batteries to explore neuropsychological or neurocognitive correlates of weight loss, and even fewer have examined neurocognitive factors contributing to successful long-term maintenance.

This is an important area for further investigation as weight loss maintenance is sufficiently complex and multifaceted to necessitate the recruitment of a subset of cognitive skills known as executive functions (EF). Executive functions involve high-order or top-down processing, and are likely among the most highly implicated cognitive systems in successful weight management. The pivotal role that executive function might play in long-term weight maintenance success requires attention to the bidirectional relationship between health behavior and neuropsychological factors, but also the crucial role that environmental factors play.

Novel treatment approaches geared towards improving weight loss maintenance outcomes will require close consideration of conceptual models of weight management that incorporate both neurocognitive and environmental influences, and ultimately, integrate executive function training strategies into our existing framework of behavioral weight loss programs (Jones, Hardman, Lawrence, & Field, 2018). While there are many levels of environmental influence that are important to consider in intervention design, the influence that romantic partners and spouses have on one another's weight management trajectories, particularly cohabitating partners, is an understudied area in the weight loss field (Black, Gleser,

& Kooyers, 1990; Cornelius et al., 2018; Gorin et al., 2013; Gorin et al., 2008). Examining the intersection of executive function and partner influence among a sample of couples engaged in a behavioral weight loss program, therefore, provides a unique opportunity to understand this crucial intersection (Gorin et al., 2017).

Chapter 1: Executive Function and Weight Management

Background and Literature Review

A review of the extant literature on the relationship between executive function and health behavior change, development of overweight and obesity, and successful weight loss is highlighted below. For a more comprehensive review of the literature please refer to Gettens and Gorin (2017).

Defining Executive Function

Executive functions (EF) are defined as “high-order” cognitive processes that enable a person to engage in independent, purposive, and goal-directed behavior, promote planning and organizational skills, and forego immediate reward for future gains (Alvarez & Emory, 2006; Lezak et al., 2012; Miyake et al., 2000; Suchy, 2009). EFs are not identified as a unitary construct but a compilation of interrelated functions associated with the same brain structures or regions (Miyake et al., 2000). Despite some debate regarding which functions comprise the core of EF, certain aspects of EF are consistently agreed upon, including shifting, working memory, and inhibition (Alvarez & Emory, 2006; Miyake et al., 2000; Suchy, 2009). Traditionally, EF is associated with frontal lobe structures, and more specifically the prefrontal cortex (PFC) of the brain (Lezak, Howieson, Loring, Hannay, & Fischer, 2012).

The distinction between general cognitive function and EF is also important to note. EFs are typically described in terms of “how” behavior is expressed, whereas cognitive function is discussed in terms of “what” or “how much” (Lezak et al., 2012). This broad definition of EF requires close consideration of specific psychological constructs that are dependent upon EF before examining the role EF might play in health behavior regulation, weight loss, and WLM. There is less uniform clarity delineating specific psychological constructs reliant on EF, and several broad models have been proposed (Baddeley, 1996; Delis, Kramer, Kaplan, & Holdnack, 2004; Luria, 1966; Miyake et al., 2000; Norman & Shallice, 1986).

Functions often tested in neuropsychological assessment include flexibility and set-shifting, working memory, decision-making, planning, organization, initiation/inhibition, verbal fluency, concept formation, and abstract thinking (Delis et al., 2004). While these processes represent more elemental components of complex neurocognitive processes like "volition" or "purposive action" that are often used to define EF broadly, three inter-related cognitive domains have consistently emerged as central to the construct of executive function: inhibition, shifting, and updating (Mikaye et al., 2000). Research suggests that each of these domains holds the potential to impact weight management success (Allan, McMinn, & Daly, 2016; Allom, Mullan, Smith, Hay, & Raman, 2018; Caldwell et al., 2018; Fitzpatrick, Gilbert, & Serpell, 2013; Jansen et al., 2015).

Executive Function, Health Behavior, and the Development of Obesity

Engagement and maintenance of health behaviors recruit substantial resources at individual and environmental levels. At the individual level, a logical relationship can be drawn between executive resources and health-behavior change, as such changes typically require substantial planning, evaluation of long term goals, and inhibition of prepotent responses to palatable food cues. The relationship between cognitive function broadly and health behavior change is empirically supported across a variety of health behaviors including diabetes management, smoking cessation, and stress regulation (Allan et al., 2016; Allom, Mullan, & Hagger, 2016; Allom, Mullan, & Hagger, 2016; Broadley et al., 2017; Gutierrez-Colina et al., 2016; Hall & Marteau, 2014; Loprinzi et al., 2015). While much research has focused on the cognitive enhancing or preserving effects of such health behaviors, including exercise and healthy eating, studies have increasingly focused on the role that executive functions play in facilitating successful initiation and continued engagement in beneficial health behaviors (Hall et al., 2008; Hall et al., 2006; Williams et al., 2009; Williams & Thayer, 2009).

Emerging research suggests that individuals with stronger executive skills are able to engage in healthy behaviors more consistently than those with executive deficits by avoiding temptations, planning behaviors necessary to meet health goals, and engaging in future-oriented thinking to sustain motivation over time (Best, Nagamatsu, & Liu-Ambrose, 2014; Hall & Marteau, 2014; Kober et al., 2010). Elderly individuals with stronger working memory are more likely to adhere to medication regimens (Insel, Morrow, Brewer, & Figueredo, 2006), smokers demonstrating increased activation in brain areas involving inhibitory control are less likely to smoke in response to cravings (Berkman, Falk, & Lieberman, 2011), the intention-behavior gap for engagement in physical activity is moderated by stronger scores on a task of inhibition (Hall, Fong, Epp, & Elias, 2008), and dieters with stronger inhibition are less likely to consume unhealthy foods and more likely to lose weight over the course of four months (Hofmann, Schmeichel, & Baddeley, 2012). These examples highlight the range and extent to which executive skills are implicated in health behavior, and that stronger executive skills may be especially important in successful engagement in and, perhaps, maintenance, of such changes.

In the obesity field, executive function has been identified as a novel avenue of research in understanding mechanisms of successful weight loss maintenance. To understand how EF might influence WLM, however, it is necessary to review the relationship between executive function and overweight or obesity (McLean et al., 2015). Existing literature (primarily cross-sectional designs) consistently indicates that overweight and obesity are associated with lower performance on both general measures of cognitive function (Smith, Hay, Campbell & Troller, 2011; Prickett, Brennan & Stolwyk, 2015; Yang, Shields, Guo, & Liu, 2018), and EF-specific domains (Boeka & Lokken, 2008; Brogan, Hevey, O'Callaghan, Yoder, & O'Shea, 2011; Cserjesi et al., 2009; Fagundo et al., 2012; Fergenbaum et al., 2009; Gunstad et al., 2007), compared to normal weight controls (NWC). Functional deficits most consistently impacted by overweight and obesity include inhibition, decision-making, concept formation, and set shifting. Furthermore, many of these deficits exist independent of associated medical conditions, education level, and general cognitive ability (Smith, Hay, Campbell, & Trollor, 2011).

Finally, a true understanding of executive function as a risk or preventative factor in the development of overweight and obesity across the lifespan will require greater attention to neuropsychological factors measured within prospective studies. Though prospective studies examining weight-related health behaviors are lacking, promising evidence from childhood and adolescent research suggests that baseline executive function predicts a range of health behaviors later in life, including BMI, physical activity, smoking and alcohol use (Fernie et al., 2013; Moffitt et al., 2011; Peeters et al., 2015). For example, Peeters et al., (2015) assessed executive function and drinking behavior over the course of a four-year period and found that working memory uniquely predicted both first drinking episode and first binge drinking episode among a sample of adolescents age 12 to 14. Similarly, Moffitt et al., (2011) followed 1,000 children from birth to age 32 and found that childhood self-control predicted physical health (e.g., respiratory, cardiovascular, dental health) independent of intelligence or SES.

These findings highlight an important dilemma underlying successful weight management; individuals who are at risk for developing overweight or obesity may also be most likely to experience challenges in sustaining weight-related health behaviors. Understanding ways in which specific executive skills might map onto distinct weight loss behaviors (Allom &

Mullan, 2014; Gettens & Gorin, 2017) will be crucial in leveraging the structure of current behavioral weight loss interventions to maximize individual executive skills and to develop novel intervention techniques, both within the current structure of behavioral weight loss interventions and independent of traditional treatment approaches.

Executive Function, Weight Loss, and Weight Loss Maintenance

In light of the aforementioned findings, executive functions are an important factor to consider in successful weight loss and, perhaps, even more important in understanding the unique challenges of weight loss maintenance (Dohle, Diel, & Hofmann, 2018; Gettens & Gorin, 2017; Jansen et al., 2015). Deficits in executive function may be a risk factor for the development of obesity and such deficits may also present challenges to successfully engage in weight-related health behavior change. The complexity of these bidirectional relationships emphasizes the importance of studying neuropsychological underpinnings of weight-related health behavior, but also raises the important question of whether weight loss might have a beneficial effect on executive function.

Indeed, research suggests that distinct executive functions are predictive of distinct weight-related behaviors (Allom & Mullan, 2014; Dassen, Houben, Allom, & Jansen, 2018). For example, sub-components of executive function (e.g., working memory and updating) are associated with preferences for high- or low- fat snack choices (Whitelock, Nouwen, van den Akker, & Higgs, 2018). Findings also indicate that initiation of healthy behaviors, such as increased PA and consumption of fruits and vegetables, requires a separate set of executive skills (e.g., working memory) than those used in the avoidance of health-risk behaviors (e.g. consumption of high fat foods and disinhibited eating) (Allan, Johnston, & Campbell, 2011; Allom & Mullan, 2014; Hall et al., 2006; Limbers & Young, 2015). Additionally, poor executive control is associated with less fruit and vegetable consumption while task-switching and flexibility predict a significant amount of variance in the intention-behavior gap for unhealthy snacking (Allan et al., 2011).

Findings regarding the impact of weight loss and decreased adiposity on EF are mixed. Very few studies have implemented prospective designs to examine the impact of diet on cognitive function, and specifically executive function, in samples with overweight or obesity. Several studies report significant negative associations between baseline BMI and cognitive function at follow up (Cournot et al., 2006; Gunstad, Lhotsky, Wendell, Ferrucci, & Zonderman, 2010; Sabia, Kivimaki, Shipley, Marmot, & Singh-Manoux, 2009; Wolf et al., 2007) while others have found significant positive associations between weight loss and executive function (Bryan & Tiggemann, 2001; Butryn, Thomas, & Lowe, 2009; Green, Elliman, & Kretsch, 2005; Gunstad et al., 2010; Halyburton et al., 2007; Siervo et al., 2012; Wing, Vazquez, & Ryan, 1995). Finally, evidence of null or negative effects of weight loss on EF are also reported throughout the literature (Bryan & Tiggemann, 2001; Cheatham et al., 2009; Espeland et al., 2014; Green et al., 2005; Halyburton et al., 2007; Martin et al., 2007). Of note, negative impacts of dieting on executive function are often attributed to the finite availability of cognitive resources, and the significant amount of cognitive control utilized during dietary restraint and preoccupation with dieting and/or body image (Siervo et al., 2011).

In summary, evidence for a bidirectional relationship between executive function and weight loss is supported throughout the literature, but inconsistencies in the pattern of findings raise several important points for future research. First, evidence supports that distinct executive functions predict unique behaviors related to successful weight loss. This is notable for future research and the development of EF-based interventions as it highlights multiple avenues for treatment and cognitive skills to be targeted. Second, it is clear that additional research is needed to clarify the impact of weight loss on executive skills. While findings generally support that executive skills are associated with weight-related health behaviors and weight loss, it is less clear whether losing weight may help to reverse the negative impact of overweight and obesity on executive functioning. Research does suggest that changes in executive function may be a better predictor of weight loss than executive skills measured at a single time point, however the stability of these observed changes due to weight loss is unknown and has not been studied longitudinally (Best et al., 2014; Bryant, Caudwell, Hopkins, King, & Blundell, 2012; Dalle Grave, Calugi, & Marchesini, 2014; Murawski et al., 2009). Whether changes in executive skills due to weight loss are permanent or transient will be an important point of future research and particularly crucial to intervention development.

Finally, few longitudinal studies have been conducted to examine the role of executive function in weight loss maintenance. The obesity field has clearly distinguished factors related to successful weight loss from weight loss maintenance (Elfhag & Rössner, 2005), yet ways in which specific executive functions (i.e., shifting, updating, inhibition) might differentially impact behaviors related to successful weight loss versus weight loss maintenance (see Figure 1) have only been hypothesized (Caldwell et al., 2018; Gettens & Gorin, 2017). The dilemma of how to promote improved rates of successful weight loss maintenance is area in clear need of more rigorous prospective investigation. Furthermore, fully elucidating the complexity of sustained health behavior change will not only benefit from, but will likely require integration of both individual neuropsychological and interpersonal social factors.

Chapter 2: Environment and Context in Weight Management

Background and Literature Review

Establishing a link between executive function and weight loss maintenance will make an important contribution to the literature on its own, however, exploring this link in a couples-based weight loss trial allows for analysis of several exploratory questions. These novel questions lie at the intersection of neurocognitive and social predictors of weight management, pushing the boundaries of what either health psychology or neuropsychology have established alone.

The significant impact of social support networks on individual and group patterns of health behavior change is well documented (Cruwys, Bevelander, & Hermans, 2015; Herman, 2015; Hill & Peters, 1998; Vartanian, Spanos, Herman, & Polivy, 2015) and several theories have formalized the interaction between social interpersonal factors and individual-level factors central to health behavior (Hall & Fong, 2007) . There is strong evidence to suggest that weight status tends to cluster in social contexts, and ecological models recognize the importance of the social and interpersonal environment in the development of obesity (Egger & Swinburn, 1997; Christakis & Fowler, 2007; Sallis, Bauman & Prat, 1998).

Weight-related health behaviors, including diet and physical activity, are among the most influenced within social networks, and particularly among spouses and romantic partners, as spouses frequently attempt and succeed at influencing their partners' health behaviors (Gorin, Powers, Koestner, Wing, & Raynor, 2014; Gorin et al., 2008) Recent studies indicate that involving spouses in weight loss interventions can be beneficial compared to standard individually focused treatment (Gorin, Raynor, Fava, et al., 2013), and results in similarities in weight change trajectories among spousal partners.

Overweight and obesity are also common within families, and weight-related health behavior change can exhibit a "ripple effect" such that spouses and children might benefit from other family members' health initiatives (Gorin et al., 2008; Schierberl Scherr, McClure Brenchley, & Gorin, 2013). In the most recent examination of this so-called "ripple effect", Gorin et al. (2018) found that among cohabitating dyads randomized to a commercial weight loss program (Weight Watchers) versus a self-guided condition, spouses entered the program with similar weight status and untreated spouses lost a significant amount of weight regardless of their partners' treatment condition. Such findings highlight the importance of dyadic dynamics at play during health behavior change (Cornelius, Gettens & Gorin, 2016), yet behavioral weight loss interventions have traditionally focused on the individual, neglecting to address crucial environmental influences exerting effects outside of the controlled intervention context.

Theoretical Foundations

Self-determination theory

Several theories of health-behavior change reflect the importance of studying the intersection between individual-level cognitive factors and social-environmental influences in health behavior change, specifically weight management. Self-Determination Theory (SDT) is unique in providing a strong theoretical basis from which to explore the association between the individual and environmental factors of weight-related goal progress within a single framework (Ryan & Deci, 2000; Williams et al., 1996). SDT posits that there are three central and universal human psychological needs: competence, autonomy, and relatedness (see Figure 2). Fulfilling these needs results in increased autonomous, or intrinsic, motivation toward goal attainment. A person is considered autonomously motivated to the extent that he or she experiences goals and decisions to be self-generated and freely chosen, as opposed to motivation that is controlled by external or internal pressures (Deci & Ryan, 2011; Ryan & Deci, 2000).

SDT process models have been tested in the context of several health behavior change studies (Williams et al., 2004) including smoking cessation (Williams et al., 2002), eating behavior and weight control (Gorin et al., 2014, Powers, Koestner & Gorin, 2008, Ng et al., 2012; Teixeira et al., 2015; Williams et al., 1996), physical activity (Teixeira, Carraça, Markland, Silva, & Ryan, 2012), and diabetes management (Williams et al., 2004). Although studies grounded in SDT originally focused on the relationships between patients and medical providers, recent studies have increasingly focused on interpersonal factors and social support between co-equal relationships, including romantic partners and spouses (Gorin et al., 2018; Koestner & Losier, 2002; Koestner, Powers, Carbonneau, Milyavskaya, & Chua, 2012; Powers, Koestner, & Gorin, 2008). Findings grounded in SDT indicate that support from important others is a better predictor of health behavior change than support from healthcare providers and underscores the importance of including peers and romantic partners in health-behavior interventions.

Temporal self-regulation theory

Temporal Self-Regulation Theory (TST) also integrates both individual neurobiological factors and environmental influence into a single theoretical model in conceptualizing successful health behavior change (see Figure 3). TST acknowledges that health behavior change is often challenging, and understanding the process by which some individuals initiate and sustain such behavioral changes requires close examination of a complex combination of biological and social influences (Hall & Fong, 2007, 2015). Specifically, TST posits that both an individual's motivational prerequisites (e.g., social connectedness and beliefs) and the temporal distance between one's intentions and actions (e.g., eating poorly now and developing cardiovascular disease 20 years from now) are crucial in predicting behavioral outcomes (Hall & Fong, 2007, 2015).

In the health behavior literature, the temporal distance between intention and action is referred to as the intention-behavior gap (Sheeran & Webb, 2016), while in the neuropsychological literature this discrepancy is conceptualized as delay discounting. Delay discounting can be reasonably defined under the umbrella of executive functions, as it requires individuals to engage in future-oriented thinking and resist immediate reward for future gain (Kishinevsky et al., 2012; McClelland et al., 2016; Stojek & MacKillop, 2017; Weller, Cook, Avsar, & Cox, 2008). TST highlights this aspect of the theoretical model as the biological basis for behavior, and defines self-regulatory capacity as an executive function associated with the prefrontal cortex.

Studies examining the application of TST in weight management have found that TST reliably predicts engagement in several weight-related behaviors. However, there is notable variability in published studies regarding specific components of the TST model that predict health behaviors. For example, one study found environmental influences, perceived cost of healthy eating, and negative affect lead to increasing snacking while self-regulation did not Elliston, Ferguson & Schuz, 2017). Another study found that participants' beliefs about health benefits, past behaviors, and habit formation predicted variance in increased fruit and vegetable intake and engagement in unhealthy snacking, but self-regulatory behavior did not (Evans, Norman, & Webb, 2017). In contrast, Book & Mullan (2013) found that, among a sample of healthy undergraduates, students who felt support by their environment were more likely to maintain healthy behaviors compared to those who felt unsupported (Booker & Mullan, 2013). Furthermore, findings indicate that whether self-regulation and behavioral prepotency (i.e., executive functions) predict maintenance of healthy behaviors depended on how supported students felt within their environment. Students who felt unsupported by their environment were more likely to maintain a healthy lifestyle if they had strong self-regulatory skills including planning and response inhibition (Booker & Mullan, 2013). These findings are notable, as they make explicit the interaction between individual-level cognitive factors and interpersonal-level social influences in health behavior change.

Core Constructs

In this study, support and social influence were conceptualized as both interpersonal and structural. To examine both, participants' perceptions of receipt of partner support and their own household environments were measured.

Social support and partner influence

The type of support one receives from their social environment is an important catalyst in the fulfillment of core needs and the development of autonomous motivation for weight-related behavior change. Interpersonal and social support is therefore essential for optimizing growth, self-directed, meaningful behavior, and overall personal wellbeing (Deci & Ryan, 2000; Hall & Fong, 2007; Gettens et al., 2018; Reeve, Bolt & Cai; 1999; Silva et al., 2010). Studies have begun to distinguish the differential impact of support styles on weight loss outcomes within social contexts (Gorin, Powers, Koestner, Wing, & Raynor, 2014; Stewart, Gabriele, & Fisher, 2012). For example, Powers and colleagues (2008) demonstrated that autonomy support could be distinguished from more directive or controlling support styles. Examples of directive or controlling support included having friends and family calling attention to or constantly reminding participants of their health goals. Results revealed that participants reported greater weight loss when they perceived their family and friends to be autonomy supportive of weight loss goals; however, no such association was found for more directive forms of support (Powers et al., 2008).

While interventions provided in an autonomy supportive fashion have generally been shown to promote greater goal attainment and adherence to health behavior change (Gorin, Powers, Koestner, Wing, & Raynor, 2014; Powers, Koestner, & Gorin, 2008; Koestner et al., 2012), recent studies have also highlighted potential benefits of more directive forms of support (Cornelius et al., 2018; Gabriele, Carpenter, Tate, & Fisher, 2011; Gorin, Powers, Koestner, Wing, & Raynor, 2014; Koestner et al., 2012; Koestner, Otis, Powers, Pelletier, & Gagnon, 2008; Powers et al., 2008).

Finally, the relationships in which support is provided is an important consideration in examining social and environmental influences of weight management. Much of the early health behavior research grounded in SDT focused on the relationship between patients and healthcare providers (Deci & Ryan, 2000), yet more recent research has underscored the importance of receiving autonomy support from significant others (e.g., close friends and family members). Specifically, findings indicate that support from important others and partners is a stronger and more consistent predictor of dietary change outcomes than autonomy support from health care providers (Williams, et al., 2006). Prior studies have found that involving significant others in the weight loss treatment process can be beneficial (McLean et al., 2003), and research indicates that partner involvement is most impactful when spouses provide autonomy support (e.g., teaching spouses to ask their partner what would be most helpful, practicing empathic active listening skills, avoiding criticism and controlling language) for behavior change (Gorin, Powers, & Koestner, 2014).

Despite evidence supporting the benefit of involving partners and spouses in weight loss interventions, studies that have attempted to engage partners and spouses in treatment have traditionally enrolled only one partner as the active participant (Black et al., 1990; Gorin, et al., 2018; Gorin et al., 2013; Leroux, Moore, & Dube, 2013) In the present study, participants were enrolled as dyads and participated equally in group treatments, allowing for a unique examination of the interaction between neurocognitive factors and interpersonal support.

CHAOS and the influence of the home environment

Behavioral weight loss programs address a range of health-behavior change techniques; evidence suggests that individuals with overweight and obesity are especially sensitive to food cues in their environment (e.g., availability of snacks in the home), and that this environment plays a key role in successful weight management (Alonso-Alonso & Pascual-Leone, 2007; Jansen et al., 2008; Lowe et al., 2012; Vartanian, Herman, & Wansink, 2008). The home food environment is, therefore, another key environmental context where weight loss efforts might be supported or undermined.

Evidence from the pediatric literature indicates that the home environment plays an important role in the development of health behavior among children. Specifically, a chaotic environment, defined as lacking structure, routine, and organization, can have adverse effects on children's ability to develop healthy habits (Appelhans et al., 2014; Fiese, Rhodes, & Beardslee, 2013) and can result in increased fat intake and snacking (MacRae, Darlington, Haines, & Ma, 2017; Vartanian, Kernan, & Wansink, 2016). In a review of 32 studies, Bates et al., (2018) reported that a less structured home environment and greater chaos within the home may be risk factors for the development of childhood obesity and that 80% of studies reviewed reported a strong relationship between at least one aspect of household organization (e.g., family routines, structured rules and limitations) and weight management among school-aged children (Bates et al., 2018).

In contrast, little research has examined the impact of the home environment on weight loss success among adults, and few prospective weight loss studies have attempted to alter structure and/or organization within the home (Gorin et al., 2013; Lowe, Butryn, & Zhang, 2018; Papas et al., 2007). Of the studies that have intervened on participants' home environments, results suggest that women achieve greater weight loss when the home environment is altered to promote healthier habits (e.g., providing exercise equipment, body and food scales, subscriptions to food delivery services and health magazines). Additionally, findings indicate that partners living with those individuals who were actively participating in the intervention also benefit from alterations to the home environment, regardless of gender (Gorin et al., 2013). These findings point to the importance of both the social and structured environment in developing and sustaining weight-related health behavior changes. Understanding the way in which environmental influences, such as support style and organization within the home, might influence an individual's success in weight loss and maintenance requires close examination of the interplay between individual-level cognitive factors and social factors. Furthermore, the way in which executive skills might set the stage for greater organization or chaos within the home is a crucial consideration.

In summary, results regarding the impact of the household structure on weight management indicate that routine, organization, and a less chaotic environment are beneficial in developing healthy habits within the home. The home environment may be a particularly relevant social factor to consider in the exploration of neurocognitive and interpersonal interactions, as multiple individuals contribute to the food environment within a household. Therefore, individuals attempting weight loss or maintenance must frequently engage their own executive skills to navigate aspects of the home environment that are structured by others (e.g., children or spouses bringing high-fat snacks into the home) and may not support successful weight management.

Intersection of Individual Cognitive and Social Factors: Addressing Gaps in the Literature

The focus on both individual-level factors (i.e., motivation, self-regulation and executive functions), as well as interpersonal and social factors (support style, social connectedness, and beliefs) within a single model allows for a unique examination of the interactions between these two domains from strong theoretical foundation. Findings grounded in both SDT and TST speak to the importance of viewing weight management not solely from an individual perspective; the social/interpersonal environment likely sets the stage for successful (or unsuccessful) weight loss maintenance and needs to be considered in both our treatment models and assessment batteries. Much of the existing weight management research exploring this crucial intersection has narrowly focused on the individual-level factor of self-regulation (Gokee-LaRose, Gorin, & Wing, 2009; Gorin, Powers, et al., 2014; Hall & Fong, 2007; Maes & Karoly, 2005; Teixeira et al., 2015). While self-regulatory capacity is considered a high-order executive skill, as mentioned previously, the construct of "executive function" covers a much broader range of cognitive abilities than self-regulation alone.

This study is one of the first to elucidate the nature of executive correlates underlying maintenance success, and potential interactions between these individual cognitive correlates and social-environmental support styles. No studies that we are aware of have examined this individual/environmental interaction on weight loss and maintenance outcomes among spousal dyads, therefore, our study makes several important contributions to the obesity and weight management literature. First, we provide longitudinal data to elucidate the role of executive function on weight loss, but also, crucially, on weight loss maintenance. Second, given that the proposed study is nested within a larger weight loss intervention focused on social and environmental factors of weight management, results from this study highlight the potential impact of weight loss on executive function performance, and the role that larger contextual factors play in such changes. Finally, the results of this study will have significant implications for the development and design of novel training modules focused on executive function as it relates to weight management.

Chapter 3: Present Study

Given the complexity of weight loss and weight loss maintenance, there is a clear need to identify both individual- and environmental-level factors processes of successful weight management. Furthermore, prospective studies are needed to provide insight into the apparent bidirectional relationship between executive function and overweight or obesity, and to understand the impact that environmental influences might have on the relationship between individual cognitive skills and health behavior change. This study was, therefore, designed to answer the following questions:

1) Does executive function predict weight loss outcomes at 6-month and 12-month follow-up, and weight loss maintenance (weight change between 6 and 12 months) in a 6-month behavioral weight loss program?
2) Does a 6-month behavioral weight loss intervention engender meaningful changes in executive function among participants?
3) Do environmental influences (i.e., support from one's spouse or partner, the nature of the home environment measured at 3 and 6 months) moderate the relationship between an individual's executive function skills and their weight loss and maintenance outcomes?

Specifically, we hypothesized that:

1. Individuals with stronger executive function skills, specifically fluency, task-switching, and inhibition, will exhibit larger weight losses at the 6-month and 12-month time points, as well as maintenance.

2a. Executive function scores will improve from baseline to 6-months and, 2b., Changes in behavioral task-based measures of executive function (e.g., speed of processing, verbal fluency, and set-shifting ability) will predict maintenance success at 12-months above and beyond baseline executive scores alone (Best, Nagamatsu, & Liu-Ambrose, 2014).

3. More structured home environments and greater levels of support provided by one's spouse or partner, experienced within the context of a behavioral intervention, will provide individuals with lower baseline executive function scores (who might otherwise be predicted to exhibit blunted weight loss, see H1) the environmental resources necessary to maximize weight loss.

Chapter 4: Methods

Overview of Primary Study

The Institutional Review Board at the University of Connecticut approved all primary study procedures and approved this sub-study of the larger TEAMS (Talking about Eating, Activity and Mutual Support) trial, a NIH-funded couples-based behavioral weight loss intervention conducted at UConn. Sixty-four cohabitating couples were randomized to either an enhanced autonomy support condition (SDT-WL) or to a more traditional model of spouse involvement (i.e., spouses attend groups but receive no training in providing autonomy support; BWL).

Couples in both conditions received 6 months of weekly behavioral weight loss group meetings, were placed on a low-fat, low-calorie (e.g., 1200-1800 calories and fat-restricted <30% calories from fat) diet, and encouraged to gradually increase their physical activity weekly until they were able to engage in 250 minutes of moderate intensity activity per week. Couples were also provided information on self-monitoring diet and exercise, cognitive restructuring skills, problem-solving, and maintenance strategies.

In addition, the SDT-WL intervention included additional support modules (approx. 5-10 minutes per class), focused on education and training in SDT-based strategies of providing autonomy support (e.g., practicing empathy, recognizing and minimizing critical comments, and asking partners what they find helpful, in order to avoid assumption). Couples in SDT-WL were given opportunities throughout the 6-month intervention to practice these strategies with the use of handouts, cartoon vignettes, role-playing, group discussion, and homework assignments provided by the group interventionists.

The primary aims of the TEAMS study were to determine whether the enhanced autonomy support-based intervention would 1) promote increases in autonomy supportive behaviors among partners, 2) lead to greater autonomous motivation and perceived competence for healthy behaviors (based on the SDT process model), and 3) lead to greater weight loss outcomes at 6- and 12- month assessments compared to standard behavioral weight loss.

Participants

Participants provided informed consent in accordance with University of Connecticut IRB policy, prior to participating. To participate in the trial couples were required to be married or cohabitating, with each participant between the ages of 18-70 years old with a BMI between 25-45 kg/m^2. Participants were excluded if either spouse reported: 1) cancer treatment within the past year, 2) substance abuse, dependence, or problematic drinking behavior over the last 30 days as indicated by the Daily Drinking Questionnaire (Collins et al., 1985), 3) a heart condition, chest pain during periods of activity or rest, or loss of consciousness on the PAR-Q (Thomas et al., 1992), 4) a history of psychotic disorder, bipolar disorder, organic brain syndromes, or hospitalization for a psychiatric disorder within the past year, 5) current participation in a weight loss program, taking weight loss medication, or lost $\geq$ 10% of body weight during past 6 months, 6) current participation in any other research study that may interfere with this study, 7) were pregnant, lactating, $\leq$ 6 months postpartum, or planned to become pregnant during the study, or 8) were deemed by staff to be unlikely to adhere to the protocol (e.g., moving).

Recruitment and Randomization

Couples were recruited to participate in a 6-month behavioral weight loss intervention with their spouse or cohabitating partner. Recruitment strategies included direct mailing and distribution of flyers across the greater Storrs-Mansfield community. Couples were screened via phone to determine whether they met eligibility criteria outlined above. If eligible, couples were invited to the University of Connecticut for an orientation session where they received pertinent information about the study and informed consent was obtained. Eligible couples were randomized via a simple, variable-block length randomization, which ensures fairly equal allocations and makes it difficult to guess future assignments. Recruitment occurred over an 18-month period from July, 2014 through December, 2016.

Assessments

To promote retention, participants received $10, $25, and $40 at the 3, 6, and 12 month assessments respectively. The couple's entire visit took approximately 3 hours at baseline (divided between 2 sessions); 15-30 minutes at 3 months; and 60-90 minutes at 6 and 12-months. During the first baseline assessment visit, all participants had anthropometric measures taken (height and weight) by a research assistant blinded to study condition. Couples were then asked to complete each of home environment and support measures**.** During the second assessment visit, participants were asked to complete the full cognitive and executive function test battery. Cognitive test batteries were administered by graduate students with formal, supervised clinical training in neuropsychological assessment by a board certified clinical neuropsychologist.

A brief assessment was conducted halfway through the program (3-months), completion of the 6-month intervention and again at 6-months post intervention (12 months post enrollment). At the 6-month time-point (immediately post-intervention), participants completed one 90-minute assessment session. The visit was comprised of two parts. Participants were first asked to complete an abbreviated questionnaire battery assessing support and the home environment. They then completed an abbreviated cognitive session, comprised of executive function measures only (i.e., D-KEFS selected subtests, Trail-Making A and B, and BRIEF self-report).

At the 12-month time point (6 months post-intervention) anthropometrics measures were taken to assess weight loss maintenance.

Measures

While the larger TEAMS trial included a range of environmental and social support measures, only those used in the executive function sub-study will be discussed below.

Anthropometric measures

Weight. Weight was measured in kilograms to the nearest 0.1 kg using a calibrated standard digital scale (Tanita BWB 800) with participants in light clothing and no shoes. Scale calibration was checked periodically with known weights. Standing height (mm) was measured in patients without shoes using a Harpenden stadiometer. All anthropometric measures were taken in duplicate and the mean used in analysis. Weight loss outcomes were calculated as percent weight loss at each time point (6 months and 12 months). Weight loss maintenance was calculated as the percent weight change from the 6-month assessment to the 12- month assessment, controlling for baseline weight.

Demographics and Weight History. Basic demographic information (e.g., age, gender, race, marital status, education, income, work status, household composition) was assessed at baseline only.

Measures of intelligence and executive function

Executive functions were measured using both objective neuropsychological test batteries and self-reported survey measures, and tests were selected to capture a range of executive skills that have demonstrated an impact on weight management in prior studies (Fitzpatrick et al., 2013; Siervo et al., 2011; Smith, Hay, Campbell, & Trollor, 2011) and would, conceptually, impact weight-related health behavior change (Gettens & Gorin, 2017). Standardized test batteries were used to probe four key components of executive function: inhibition, task-switching, processing speed, and fluency. In addition, we obtained subjective self-report measures of executive functions as they impact participants' daily living. Follow-up measures of executive function were conducted at 6-months to capture change scores over the course of the weight loss intervention. Participants did not receive any diagnostic feedback regarding their performance. For hypotheses 1 and 2, we utilized all nine scales of the BRIEF-A to examine all possible executive skills associated with weight loss and maintenance, and whether any of the nine skills changed over the course of the intervention. Because hypothesis 3 was exploratory, we utilized the three subscales that measure aspects of executive functioning that represent the core executive skills (Miyake et al., 2000): inhibition, shifting, and working memory.

Intellectual Functioning. To assess and control for baseline intellectual functioning (IQ), each participant completed the *Wechsler Abbreviated Scale of Intelligence* (WASI; Wechsler, 1999) two-subtest IQ battery. The two-subtest battery can be conducted in approximately 15 minutes. The two-subtest version of the WASI is comprised of Vocabulary and Matrix Reasoning tests, and results in a Full-Scale IQ (FSIQ) score. The Vocabulary subtest measures word knowledge, verbal concept formation, and fund of knowledge, while the Matrix Reasoning subtest measures visual information processing and abstract reasoning skills.

Inhibition. The D-KEFS Color-Word Interference Test (Delis, Kaplan, & Kramer, 2001) was used to measure participants' ability to inhibit a dominant and automatic verbal response. The Color-Word Interference Test is comprised of four subtests. The two control tasks require participants to read color names printed in black ink, and identify specific blocks of color. The inhibition subtest requires participants to name the color of the ink for an incongruent word (e.g., the word “red” printed in yellow ink). The final task requires participants to engage in inhibition and switching. Scores were calculated as the total time, in seconds, to complete each condition. Completion of the D-KEFS subtests took approximately 30 minutes.

Verbal fluency. The D-KEFS Letter and Category Fluency tests (Delis, Kaplan, & Kramer, 2001) were used to measure participants’ expressive language fluency and category switching abilities. In the letter fluency task, participants were given 60-seconds and asked to provide as many proper nouns as possible that begin with the assigned letter. In the category fluency task, participants were given 60-seconds and asked to list as many items as possible that fall within a given category (e.g., animals). Scores on the D-KEFS Verbal Fluency Task were calculated as total number of correct words within the specified semantic category (animals) generated within a 60 second time-period.

Processing speed and set-shifting. The Trail-Making Test A and B versions (Parkington & Leiter, 1949) were administered to measure basic visuomotor processing speed (Trails A) and set-shifting ability (Trails B). The Trail-Making tasks consist of 25 circles distributed over a sheet of paper. In part A, circles are number 1-25, and participants were asked to connect the circles as quickly as possible in ascending numerical order. In part B, the circles are labeled both numerically and alphabetically. Participants were required to connect the circles in alternating numerical and alphabetical sequence. Scores were calculated as the total time, in seconds, required to complete each task.

Executive function in daily living. The Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A; Roth, Isquith, & Gioia, 2005) was used to measure domains of participants' baseline executive function skills. The BRIEF-A is a standardized measure that captures views of an adult's executive functions or self-regulation in his or her everyday environment and has been validated with a range of clinical populations including individuals with obesity (Roth, Lance, Isquith, Fischer, & Giancola, 2013; Rouel, Raman, Hay, & Smith, 2016). The battery is composed of 75 items within nine non-overlapping theoretically and empirically derived clinical scales. These scales include Inhibition, Self-Monitoring, Planning/Organization, Shifting, Initiating, Task Monitoring, Emotional Control, Working Memory and Organization of Materials. Subscale scores were calculated according to the guidelines by Roth, Isquith, & Gioia (2005; 2013) by summing a subset of the 75-items questionnaire that correspond to each underlying executive function construct.

Participants were asked to complete the 75-item self-report scale at baseline and 6-month follow-up. Response options correspond to the degree of difficulty participants experience with each behavior on a daily basis. Items are endorsed a 3-point Likert scale with 1 corresponding to "never", 2 to "sometimes" and 3 to "often". Example items are, "I have trouble changing from one activity to another" (shifting), "I have problems waiting my turn" (inhibition), and "I have trouble with jobs or tasks that have more than one step" (working memory). The nine scales demonstrated acceptable levels of internal consistency (α= .70-.89).

Measures of support and home environment

Autonomy support. To measure autonomy support, participants were asked to complete items adapted from the Important Other Climate Questionnaire (IOCQ) (Levesque et al., 2007; Powers et al., 2008). Six items measure the perceptions of autonomy support that partners experience from one another (e.g., “My partner conveys confidence in my ability to control my own weight”). Participants rate each item on a 7-point Likert scale ranging from 1 “not at all true” to 7 “very true.” Example items include “I feel that my spouse/partner provides me with choices and otptions about managing my weight” and “I am able to be open with my spouse/partner about my weight management goals” (α= .81). Scores were calculated as the mean of the items.

Directive support. Seven items assessing more directive or controlling forms of support were added to the IOCQ consistent with the published literature (Powers et al., 2008). Example items include “My spouse repeatedly reminded me of my goal” and “My spouse consistently called attention to situations where I had to control my behavior” (α= .84). Support was assessed at baseline, 3, 6, and 12-month time points. Receipt of support from one’s spouse or partner was scored by taking the average of the items corresponding to either autonomy support or directive support (Powers et al., 2008). Scores were calculated as the mean of the items.

Chaotic environment. The Confusion, Hubbub, and Order Scale: (CHAOS) (Matheny, Wachs, Ludwig & Phillips, 1995) was used to measure environmental confusion in the home. Participants were asked to respond on a 5-point Likert scale to items describing the level of chaos in their home, using a 5-point scale (1 = “Definitely Untrue”, 5 = Definitely True). The scale has acceptable levels of internal consistency (α= .79-.88) and is associated with observational measurement of home environment (Matheny et al., 1995). The CHAOS measure was scored by taking the sum the 15 items (Matheny, Wachs, Ludwig, & Phillips, 1995), with possible scores ranging from 15 to 60.

Data Analysis Strategy

Statistical analyses were performed using the Statistical Package for the Social Sciences, Release 25 (SPSS; IBM Corp., 2012, Armonk, NY, www.spss.com). To account for interdependence in the data (i.e., couples are likely to be more similar to each other than to other study participants), dyadic analyses were conducted according to guidelines outlined by Kenny, Kashy & Cook (2006). Specifically, multilevel models (MLM) that allow for missingness in data were specified using the MIXED linear function in SPSS. We used a longitudinal three-level repeated-measures model, in which individuals are nested within spousal dyads (see Figure 5). Maximum likelihood (ML) estimation was used given that the models differed in fixed effects.

The primary outcome variables for the present study were percent (%) weight loss from baseline to 6 months, baseline to 12 months, and maintenance of weight loss calculated as percent (%) weight change from 6 months to 12 months. Before conducting primary analyses to address each of the study hypotheses, descriptive statistics and correlations were examined. Descriptive statistics were reported as N and percentage values for all categorical variables and as means and standard deviations for all continuous variables. Any demographic variables found to be correlated with the primary outcome variables were included as covariates in all analyses. In line with the existing neuropsychological and obesity literature, age, education, and IQ were included as covariates in all analyses. Finally, to account for the potential impact of the intervention, group assignment (SDT-WL versus BWL was controlled for in all analyses.

Results

A total of 64 couples (128 individuals) were recruited for participation in this study. Neuropsychological data were collected from 63 dyads (126 individuals) at baseline, and 60 couples (120 individuals) at 6-month follow-up. A total of 9 couples plus 1 individual dropped out of the study: 5 couples in BWL and 4 couples and 1 individual in SDT-WL. One couple did not complete the 3-month assessments for TEAMS+ but returned for the 6- and 12-month assessments (see Figure 4).

Preliminary Analyses

Prior to conducting primary analyses, data were inspected for outliers (i.e., ± 3 SD's from the mean). One outlier was detected for Trails A and D-KEFS Inhibition at baseline, while two outliers were detected for Trails B at baseline. At 6 months, one outlier was detected for Trails A and Trails B. Outliers were excluded from regression analyses. Next, to examine the association between objective neuropsychological measures and self-report measures of executive function Pearson correlations were calculated (see Tables 5-8). Due to the indistinguishable nature of the data, interpretation of these correlations is limited to the coefficient value and not the p-value, as indistinguishable data produce biased p-value estimates (Kenny, Kashy, & Cook, 2006).

Intervention Group Differences

Although the primary hypotheses for the sub-study did not include the impact of intervention group (i.e., BWL versus SDT-WL) on changes in executive function or on the relationship between executive functions and weight loss outcomes, we examined potential group differences among primary study predictors (i.e., baseline and 6 month executive function, partner support and CHAOS) and primary outcome variables of interest (i.e., changes in executive function from baseline to 6 months and percent weight loss at 6 and 12 months, and maintenance). Regression analyses predicting 6 month, 12 month and maintenance controlled for group.

Multilevel Models

Three separate regression models were run for objective neuropsychological measures of executive domains grouped by test type: Tails A and B in the first model, the D-KEFS Color-Word Interference Inhibition and Inhibition/Switching measures in a second model, and D-KEFS Verbal fluency and Category fluency measures in a third model. Finally, the 9 subscales of the self-report BRIEF-A measure were entered together in a single model, but separate from the objective assessment measures to distinguish objective neuropsychological measures from subjective measures of similar constructs. Each of these models regressed percent weight loss at 6 months, 12 months, and maintenance onto executive function measures.

To explore the potential moderating effect of the home environment and/or partner support on the relationship between executive function and weight loss outcomes (Hypothesis 3), all support and environmental predictor variables were first grand mean centered (Aiken & West, 1991). High and low levels of the moderator (i.e., CHAOS, autonomy support, and directive support) were then created at +1SD and -1SD of the mean-centered variable. To aid interpretation of models, results are presented by hypothesis. Detailed results of regression models predicting percent weight loss at 6-months, 12-months and maintenance are presented in Tables 13 and 14. In line with both the weight management and neuropsychology literatures, regression analyses controlled for group, age, baseline BMI, and IQ scores.

Demographic Characteristics

Table 1 displays the demographic characteristics of the study sample by intervention group. Participants were, on average, 54 years old (SD = 10.05) and 92.2% White (one couple identified as Hispanic, one couple and one individual identified as Black, and one couple and one individual identified as Asian). The sample was half male and half female. Two couples identified as same-sex. Participants were highly educated with 20.3% attaining a bachelor's degree and 38.3% higher than a bachelor's. Median household income was high ($75,000 or above) mean IQ was in the high average range (116.2 ± 11.1). Participants' average executive function scores were within normal limits compared to age, race, and education-matched peers (Heaton, Avitable, Grant, & Matthews, 1999). Average BRIEF-A subscale measures were also in the expected range (Roth, Isquith, & Goia, 2005).

At baseline, participants weighed an average of 97.67 kilograms (SD = 19.93). Average weight change at completion of the 6-month intervention was -10.44 kg ± 6.49 (-10.55% ± 6.75), and average weight change at 12-month follow-up was -9.20 kg ± 8.15 (-9.14 % ± 8.42). Treatment condition was unrelated to baseline demographic variables (see Table 1), measures of executive function at baseline or 6 months, household chaos, or support measures (see Tables 5, 7, 9 and 11). There were no group differences in percent weight loss at either 6 months or 12 months.

Hypothesis 1*: Baseline executive function will positively predict weight loss outcomes at 6-months and 12-months.* Detailed results for models with objective neuropsychological measures (Trails A and B, D-KEFS, and Fluency) are displayed in Table 13. Detailed results for the model with self-report BRIEF-A scales are displayed in Table 14.

We found mixed support for hypothesis 1. Trails A and B were entered together in the first model. In line with study predictions, Trails A, a measure of processing speed, marginally predicted percent weight loss at 12 months (B =.16, [-.01, .32], p =.07) such that faster performance predicted greater percent weight loss, but did not predict percent weight loss at 6 months or maintenance. Trails B, a measure of shifting, significantly predicted percent weight loss at 6 months (B= .05, [.01, .11], p=.01), 12 months (B= .08, [.01, .13], p=.01), and maintenance success (B=.03, [.003, .07], p=.03). Results indicate that the faster participants completed the Trails B task, the greater their percent weight loss at 6 month, 12 months, and maintenance. Finally, consistent with some prior studies, we regressed weight loss outcomes onto the difference score between Trails B and A ("Trails B-A"). This difference score has been conceptualized as a more direct measure of switching ability, independent of visual scanning and motor speed (Arbuthnott & Frank, 2000). At baseline, the Trails B-A score, did not predict percent weight loss at 6 or 12 months or maintenance[1]. Furthermore, the Trails B-A score at 6 months did not predict percent weight loss at 12 months or maintenance.

The D-KEFS Color-Word Inhibition and combined Inhibition/Switching tasks were entered into a second distinct regression model. Covariates remained the same. Contrary to study hypotheses, neither the Color-Word Inhibition task nor the Inhibition/Switching task predicted percent weight loss or maintenance at any time point.

Next Verbal Fluency and Category Fluency measures from the D-KEFS were entered together in a third model. Again, contrary to study hypotheses, neither Verbal Fluency nor Category Fluency predicted percent weight loss at 6 months or 12 months. Neither measure predicted maintenance success.

Each model was then run with interaction terms between executive measures and group to ensure no effects by group. No significant interactions were found. Results reported above remained the same with interaction terms included in the models.

[1] The extant literature on the relationship between executive function and weight management is nascent, and findings are mixed. Several studies have used the difference score between Trails A and B ("Trails B-A") as a measure of pure switching ability, while others measured Trails A and Trails B separately (M. et al., 2011; Yang, Shields, Guo, & Liu, 2018).

Finally, the self-report BRIEF-A subscales were entered together into a single model. No subscales predicted percent weight loss at 6 months or 12 months, however, the Initiation (*B*= .14, [.01, .26], p = .04) and Inhibition (*B* = .14, [.01, .26], p=.04) subscales significantly predicted maintenance, such that the less difficulty participants endorsed at baseline, the better their weight loss maintenance. The Task Monitoring subscale also significantly predicted maintenance but in the negative direction, such that the greater difficulty participants endorsed in Task Monitoring at baseline, the better their maintenance (*B*= -.14, [-.26, -.02], p= .03).

Hypothesis 2*:* *Executive function scores will improve from baseline to 6-months due to existing intervention strategies (e.g., meal planning and self-monitoring of diet and exercise), and magnitude of weight loss.* Detailed results for models with objective neuropsychological measures (Trails A and B, D-KEFS, and Fluency) and BRIEF-A subscales are displayed in Table 15. This hypothesis was partially supported. In line with study predictions, Trail Making A, (*B* = -3.29, [-5.08, -1.49], p = .001); D-KEFS Color-Word Inhibition (*B* = -1.93, [-3.7, -0.15], p = .03), and D-KEFS Task Switching (*B* = -5.45, [-8.9, -1.96], p = .003) scores improved over the course of the 6-month intervention.

Similarly, the BRIEF-A subscales of Emotional Control (*B* = 2.05, [.40, 3.71], p=.02), Self-Monitoring (*B* = 1.70, [.22, 3.20], p=.03), Initiation (*B* = 3.63, [2.1, 5.2], p <.01), Working Memory (B = 2.40, [.77, 4.0], p =.01), Planning and Organization (*B* = 1.54, [.03, 3.1], p=.05), Task Monitoring (B =2.70, [1.2, 4.2], p <.01) and Organization of Materials (B =2.88, [1.5, 4.3], p <.01) scores improved over the course of the 6-month intervention. Counter to study hypotheses, Trails B (p=.72), Letter Fluency (p= .52) and Category Fluency (p=.32) did not change. Similarly, changes in BRIEF-A subscales of Inhibition (p=.25) and Shifting (p=.06) were not significant.

Hypothesis 2b*: Change scores will be a better predictor of weight loss and maintenance than baseline scores alone.* Detailed results for models with objective neuropsychological measures (Trails A and B, D-KEFS, and Fluency) and for the model with self-report BRIEF-A scales are displayed in Table 16.

Contrary to hypotheses grounded in prior research by Best et al., (2014) we found mixed support. Models were determined by using change scores of executive function measures that demonstrated significant changes from baseline to 6 months (see Hypothesis 2a). Changes in Trails A did not significantly predict percent weight loss at any time point (p values = .43 and .23 respectively) or maintenance (p=.32). Similar patterns were found for Color-Word Inhibition (p values = .35, .12, and .93 respectively) and Color-Word Inhibition/Switching (p values = .22, .20, and .66 respectively).

No changes in BRIEF-A subscales predicted weight loss at 6 months (see Table 8), however, changes in the BRIEF-A Self-Monitor subscale significantly predicted weight loss at 12 months (B = -1.28, [-2.32, -.24], p =.02), such that greater improvements over the 6-month intervention predicted greater percent weight loss. Changes in the BRIEF-A Initiate subscale predicted maintenance success (B = .66, [.20, 1.15], p=.01). In both cases, model fit was stronger for change scores than baseline scores alone (Self-Monitoring = (F (1, 46.3) = 8.36, p=.006; Initiation = F(1, 63.6) = 8.63, p=.005). No other changes in BRIEF-A subscales predicted percent weight loss or maintenance.

Hypothesis 3: *Environmental factors will interact with baseline executive function skills such that greater spousal support and a less chaotic home environment will allow individuals with lower baseline executive scores (See Hypothesis 1) the structure necessary to maximize weight loss.*

Autonomy support and executive function: 6-month weight loss

Detailed results for models examining the interactions between executive function (Trails A and B, D-KEFS, and Fluency) and autonomy support are displayed in Tables 17-20. Measures of autonomy support and directive support collected at the 3-month assessment point were used in these analyses only to assess the relationship between executive function and weight loss outcomes at different levels of support experienced during the intervention (rather than baseline levels of support). A subset of BRIEF-A scales were selected for these exploratory analyses based on the executive domains hypothesized to be most relevant to behavioral weight loss interventions and successful weight management (Gettens & Gorin, 2017; Miyake et al., 2006).

Objective executive function measures. We first examined interactions between executive skills and autonomy support predicting percent weight loss at 6-months (program completion).

There was a significant interaction between Color-Word Inhibition and 3-month autonomy support predicting percent weight loss at 6 months (B = -.10, [-.22, -.003] p=.04). At high levels of autonomy support, performance on the Color-Word Inhibition task was not associated weight loss at 6 months (p = .06), but at low levels of autonomy support, performance on Color-Word Inhibition was associated with greater weight loss (B= .45, [.05, 1.44], p =.03) (See Figure 6).

There were no significant interactions between any of the other objective measures of executive function (Trails A, Trails B, Verbal fluency, Category, fluency) and autonomy support predicting weight loss at 6-months.

Self-report executive function measures. When examining interactions between autonomy support at 3-months (halfway through the intervention) and BRIEF-A subscales predicting 6-month weight loss, significant interactions were found between autonomy support and Shifting (*B* =.23, [.04, .40], p=.02), Inhibition (*B* = -.34, [.11, .67], p=.01) and Working Memory (*B* = -.34, [-.51, -.20], p<.01) subscales.

At high levels of autonomy support, Shifting (*B* = 1.50, p=.01) and Inhibition (*B* = 2.23, p=.01) were associated with greater percent weight loss at 6 months (see Figures 7 and 8), while Working Memory was associated with less weight loss at 6 months (*B* = -2.04, p<.01; Figure 9).

At low levels of autonomy support, Shifting (*B* = -1.24, p=.03) and Inhibition (*B* = -2.64, p=.01) were associated with lower percent weight loss at 6 months, while Working Memory was associated with greater percent weight loss at 6 months (*B* = 2.23, p<.01).

Self-Monitoring did not interact with autonomy support to predict percent weight loss at 6 months.

Autonomy support and executive function: 12-month weight loss

Objective executive function measures. Next, we examined interactions between autonomy support and executive skills predicting percent weight loss at 12-month follow up.

There was a significant interaction between Trails A and autonomy support measured at 6-months (program completion) predicting percent weight loss at 12 months (*B* = .21, [.001, .412], p=.05). At high levels of autonomy support, Trails A performance was associated with more weight loss at 12 months (*B* = 1.27, [.14, 2.40], p=.03), while at low levels of autonomy support, Trails A performance was not associated with percent weight loss at 12 months (p = .09) (See Figure 10).

No other significant interactions were found between objective measures of executive skills (Trails A, Trails B, Verbal fluency, Category fluency or D-KEFS Inhibition) and autonomy support (measured at 3 months or 6 months) predicting 12-month weight loss.

Self-report measures of executive function. The same pattern of findings predicting 6-month weight loss were found to predict 12-month weight loss (see Figures 7 to 9). At high levels of autonomy support, Shifting (*B* = 1.81, p=.01) and Inhibition (*B* = 3.00, p=.01) were associated with greater percent weight loss at 12-months, while Working Memory is associated with less percent weight loss (*B* = -2.40, p=.01). At low levels of autonomy support, Shifting (*B* = -1.60, p =.01) and Inhibition (*B* = -3.15, p<.01) were associated with less percent weight loss at 12 months, while Working Memory was associated with greater percent weight loss (*B* = 2.54, p<.01).

Self-Monitoring did not interact with autonomy support to predict weight loss at 12 months. Furthermore, significant interactions between autonomy support and Shifting, Inhibition, and Working Memory dropped off when autonomy support was examined at the 6-month time point.

Autonomy support and executive function: maintenance success

Objective executive function measures. Finally, we examined interactions between autonomy support and objective measures of executive function (Trails A, Trails B, Verbal Fluency, Category Fluency and D-KEFS Inhibition) predicting maintenance success. No significant interactions were found.

Self-report measures of executive function. No significant interactions were found between BRIEF-A subscales and autonomy support measured at 3 months or 6 months, predicting maintenance success.

Directive support and executive function: 6-month weight loss

Detailed results for models examining the interactions between executive function (Trails A and B, D-KEFS Inhibition and Fluency) and directive support are displayed in Table 21 and 22.

Objective measures of executive function. No significant interactions were found between Trails A, Trails B, Verbal fluency, Category fluency, or D-KEFS Inhibition and directive support measured at 3 months predicting percent weight loss at 6 months.

Self-report measures of executive function. Similarly, there were no significant interactions between any of the BRIEF-A subscales and directive support measured at 3 months (halfway through intervention) predicting percent weight loss at 6 months.

Directive support and executive function: 12-month weight loss

Objective measures of executive function**.** Next, we examined interactions between objective measures of executive function and directive support predicting 12-month weight loss. There was a significant interaction between Trails A and directive support measured at 3-months predicting weight loss at 12 months (B = -.12, [-.22, -.02], p=.02). At high levels of directive support, Trails A performance was not associated with weight loss, but at low levels of directive support, Trails A performance was associated with greater weight loss at 12 months (B= .59, [.17, 1.02], p=.01). No other significant interactions were found between objective measures of executive function and directive support measured at either 3 months or 6 months (see Figure 11).

Self-report measures of executive function**.** No significant interactions were found between BRIEF-A measures and directive support measured at either 3 months or 6 months predicting 12-month weight loss.

Directive support and executive function: maintenance success

Objective measures of executive function. No significant interactions were found between Trails A, Trails B, Verbal fluency, Category fluency, or D-KEFS Inhibition and directive support measured at either 3 months or 6 months predicting maintenance success.

Self-report measure of executive function. A significant interaction was found between Self-Monitoring and directive support predicting maintenance success (B = .10, [.02, .18], p= .01). At high levels of directive support, Self-Monitoring was associated with greater maintenance success (B = .30, $p<.01$). At low levels of directive support, Self-Monitoring was not associated with maintenance success (p=.80). No other significant interactions were found between BRIEF-A subscales and directive support measured at either 3 months or 6 months predicting maintenance success (see Figure 12).

Household chaos and executive function: 6-month weight loss

Objective measures of executive function. No significant interactions were found between objective measures of executive function and household CHAOS.

Self-report measures of executive function. When examining interactions between household chaos and BRIEF-A subscales, Self-Monitoring (B = .03, [.00, .05], p=.04) significantly interacted with baseline household chaos to predict percent weight loss at 6 months (see Figure 13). At high levels of household chaos, Self-Monitoring skills were associated with greater percent weight loss at 6 months (B = .43, p =.01) while at low levels of household chaos, Self-Monitoring skills were not associated with percent weight loss (p= 1.0).

Household chaos and executive function: 12-month weight loss

Objective measures of executive function. No significant interactions were found between objective measures of executive function and household CHAOS measured at baseline or 6 months predicting 12-month weight loss.

Self-report measures of executive function. Both Working Memory (*B* = -.04, [-.10, -.01], p=.01) and Inhibition (*B* = .05, [.01, .08], p=.03) significantly interacted with household CHAOS to predict weight loss at 12 months (see Figures 14 and 15 respectively). At high levels of CHAOS, Working Memory was not associated with percent weight loss (*B* = -.33, p=.09), while Inhibition was associated with greater percent weight loss (*B* = .43, p=.05). At low levels of CHAOS, Working Memory was associated with greater percent weight loss (*B* = .40, p=.01) while Inhibition was not associated with weight loss (p=.13).

Household chaos and executive function: maintenance success

Objective measures of executive function. No significant interactions were found between objective measures of executive function and household CHAOS, measured at either baseline or 6 months, predicting maintenance success.

Self-report measures of executive function**.** No significant interactions were found between BRIEF-A subscales and household CHAOS measured at either baseline or 6 months predicting maintenance success.

Chapter 6: Discussion

This study sought to examine the relationship between executive function, weight loss, and weight loss maintenance in the context of a 6-month, couples-based behavioral weight loss program. This study is one of the first to explore the predictive validity of executive functions on both initial weight loss and long-term maintenance in a longitudinal behavioral intervention design, rather than cross-sectional or in a surgical weight loss program. Furthermore, to our knowledge, this is the first study to explore potential interactions between executive functions, and environmental factors (i.e., social support and household structure) at play in successful weight management.

In line with prior research, we found mixed support for each of our three central hypotheses that, 1) Baseline executive function would positively predict weight loss outcomes at 6-months and 12-months, 2) Executive function scores would improve from baseline to 6-months due to existing intervention strategies and magnitude of weight loss, 2b) Change scores would be a stronger predictor of weight outcomes than baseline scores alone, and 3) Environmental factors would interact with baseline executive function skills such that greater spousal support and a less chaotic home environment would allow individuals with lower baseline executive scores the structure necessary to maximize weight loss.

Effects were not significant across all models and some differences were observed between objective neuropsychological measures of executive function and participants' self-reported executive skills in terms of predictive validity in weight loss and maintenance, as well as interactions with environmental influences. Many of the executive functions measured in this study improved over the course of the 6-month intervention, and several executive functions reliably predicted weight loss; however, these effects were not all in the expected direction.

The present study makes novel contributions to the existing weight management literature. Results shed light on the challenging process of maintaining weight loss, as we were able to identify several executive functions that may contribute to successful maintenance. Furthermore, we found evidence for some interactions between executive functions and environmental influences. While this pattern of findings was also mixed, our results point to the importance of conducting future research that examines the complex intersection of both individual-level and social/environmental influences in weight management and highlights the clear need for interventions that address both.

We first explored the predictive validity of both objective and self-reported executive functions on weight loss at 6-months, 12-months, and maintenance. Cognitive sequencing and flexibility (Trails B) emerged as the only executive function that predicted weight loss at completion of the weight loss intervention (6-months) and maintenance success, while both basic attention/processing speed (Trails A) and cognitive sequencing/flexibility (Trails B) predicted weight loss at 12-month follow-up. Indeed, cognitive flexibility has been identified previously as a crucial factor in successful weight loss and maintenance (Elfhag & Rössner, 2005; M. Siervo et al., 2011; Spitznagel et al., 2015), and has been found to predict successful avoidance of unhealthy behaviors that may undermine successful weight loss and maintenance, such as snacking, disinhibited eating, and consumption of high fat foods (Allan et al., 2011; Allom & Mullan, 2014; Hall et al., 2006; Limbers & Young, 2015).

Of participants' self-reported executive skills, less difficulty on both the Initiation and Inhibition subscales of the BRIEF-A measure predicted greater weight loss maintenance. These findings are also in line with previous research emphasizing the important balance between initiating healthy behaviors and inhibiting unhealthy behaviors in successful weight management. Findings repeatedly suggest that initiating healthy weight-related behaviors utilizes a unique set of executive functions than avoiding or inhibiting inhibition unhealthy weight-related behaviors. Notably, only one previous study has utilized the BRIEF-A to predict weight loss outcomes (Galioto et al., 2018). Although this study examined self-report executive functions within a sample of bariatric patients, similar results were found. Greater self-reported difficulty on measures of Emotional Control, Working Memory, and Initiation subscales predicted higher weight status at 8-weeks post-surgery.

There are several potential reasons why fewer executive functions predicted weight loss at the end of the active phase of treatment (6-months) than at 12-months and maintenance. First, both intervention groups (BWL and SDT-WL) were couples-based and the importance of social influence was clearly emphasized in the context of group intervention meetings. Participants were also learning and integrating many new strategies into their routines to engage in healthy lifestyle changes and avoid unhealthy patterns (e.g., finding a walking partner to meet physical activity goals). It is possible that during the time participants were fully immersed in the behavioral program, the structure imposed by weekly meetings allowed weight loss behavior to become less cognitively taxing or effortful. Therefore, individual-level cognitive resources may have been relied upon less heavily than during the 6-month maintenance period in which no groups were held and no treatment was provided. Findings from the bariatric surgery literature mirror this hypothesis (Spitznagel et al., 2013) , indicating that while some executive skills may not predict weight loss outcomes during earlier post-surgical assessment points (i.e., 12 weeks), they do predict weight loss outcomes further out (i.e., 12 months).

Less clear is why self-report measures and objective measures of similar executive skills were not concordant and did not predict weight loss or maintenance in the same way. There is some evidence to suggest that self-report measures of executive function do not correlate with objective neuropsychological tasks, and may underestimate true levels of cognitive deficits across multiple patient populations (Benedict et al., 2004; Bond et al., 2010; Burdick, Endick, & Goldberg, 2005; Garcia et al., 2013). Indeed, in the present study, none of the self-report subscales of the BRIEF-A were correlated with objective task-based measures of executive function. In contrast, recent findings from the bariatric literature indicates that self-report measures of executive skills reliably predict post-surgical weight loss, arguing that this method is more efficient and cost-effective than conducting a full neuropsychological assessment (Galioto et al., 2018). As research continues to develop on the relationship between executive functions and weight loss maintenance, it will be important to consider the ecological validity of neuropsychological assessment and self-report measures of executive skills specific to weight loss and maintenance. Self-report measures like the BRIEF-A, that provide participants with specific examples of daily functions that rely on executive skills, may be particularly useful if adapted to reflect weight-related health behaviors.

Next, because executive dysfunction is consistently found among individuals living with overweight and obesity (Cserjesi et al., 2009; Gunstad et al., 2007; Prickett et al., 2015), we examined whether executive functions improved over the course of a standard 6-month behavioral weight loss program. While the extant literature examining the impact of weight loss, specifically, on cognitive functioning is mixed (Bryan & Tiggemann, 2001; Cheatham et al., 2009; Espeland et al., 2014; Green et al., 2005; Halyburton et al., 2007; Martin et al., 2007, Siervo, et al., 2012), a recent review of 13 longitudinal designs suggests that seven studies utilizing dietary interventions had a significant impact on executive function and that this effect was larger than effects seen in bariatric surgery interventions (Veronese et al., 2017). We hypothesized that executive functions might improve both due to weight loss and the potential reversal of the harmful cognitive effects of reduced blood flow, abnormalities in glucose and insulin levels, and increased adiposity resulting from overweight and obesity (Biessels & Reagan, 2015; Boeka & Lokken, 2008; Gonzales et al., 2010), as well as skills honed through core behavioral weight loss lessons including planning, organization, long-term goal setting, and self-monitoring.

In terms of objective measures, basic attention/processing speed (Trails A), ability to inhibit a prepotent response, (D-KEFS color-word inhibition), and a complex task of combined inhibitory control and cognitive flexibility (D-KEFS color-word inhibition/switching) all improved from baseline to 6 months. When examining self-report measures, participants endorsed less difficulty on Emotional Control, Self-Monitoring, Initiation, Working-Memory, Planning and Organization, Organization of Materials, and Task Monitoring subscales at study completion. Many of these skills are explicitly addressed in the context of standard behavioral weight loss programs (Olson, Bond, & Wing, 2017). For example, self-monitoring of both daily calorie intake and energy expenditure is a central lesson in behavioral weight loss programs. Planning and organization skills are addressed in the context of thinking ahead for challenging or tempting social eating situations, emotional control is discussed as a potential antecedent to disinhibited or over eating episodes, and initiation of healthy behaviors, such as asking a friend to go on daily walks, are emphasized throughout weekly lessons.

Contrary to previous findings suggesting that change in executive function may be a stronger and more consistent predictor of weight-related behavior and weight change than executive function measured at a single time point (Best et al., 2014; Bryant et al., 2012; Dalle Grave et al., 2014; Murawski et al., 2009), we found little evidence that change scores were a stronger predictor of weight loss or maintenance. None of the change scores detected in objective measures of executive function predicted weight loss or maintenance, while only changes in self-reported Initiation and Self-Monitoring subscales predicted weight loss and maintenance success.

While improvement in these skills certainly has the potential to impact weight loss and maintenance, it should be noted that improvements in self-report measures may be a proxy for enhanced self-efficacy among participants, as they realize weight loss success. Nevertheless, results indicating that executive functions are improving over the course of a 6-month intervention have important clinical implications, specifically, that executive skills demonstrate potential to change, even among a sample of middle-aged adults. Second, it suggests that the content of standard behavioral weight loss programs may not only lead to significant weight loss, but may also target important underlying cognitive processes that allow participants to sustain lifestyle changes learned during the intervention. Additional research is needed to determine which aspects or lessons within behavioral weight loss interventions mediate these changes. Once mediators are determined, future intervention designs should seek to enhance these elements with the goal of improving weight loss maintenance.

Finally, we conducted novel exploratory analyses that examined the important intersection between individual-level executive skills and environmental support factors at play in the weight management process. To our knowledge, no studies have explored this intersection in the context of a behavioral weight loss program, despite several theories (i.e., Temporal Self-Regulation and Self-Determination Theory) highlighting the importance of accounting for both individual and environmental level variables in health behavior change (Liesel & Barbara, 2013; Ryan & Deci, 2002). In general, a pattern emerged such that at high levels of support, stronger executive function skills predicted greater weight loss and maintenance success. Although some prior research has indicated that autonomy support is associated with better weight loss outcomes than directive support (Gorin, Powers, et al., 2014; Koestner et al., 2012; Koestner et al., 2012; Ryan & Deci, 2002), we found that the link between executive function skills and weight management was replicated regardless of support type, with the exception of Trails A. These findings support some prior work (Cornelius et al., 2018) that suggests more prescriptive or directive forms of support, which are often considered to be harmful, may be beneficial in certain contexts (e.g., individuals with stronger executive functions).

In low support environments, the relationship between executive function and weight loss success was more variable. Results suggest that in low support environments, stronger executive skills did not always lead to greater weight loss outcomes. For example, while inhibitory control and shifting were associated with less weight loss in low support contexts, processing speed and working memory skills were associated with greater weight loss. It is possible, then, that certain executive skills are more beneficial to recruit than others when social supports are lacking, while strong performance in other executive domains is not sufficient to overcome the challenge of health behavior change with little social support.

While there is a paucity of research on such interactions in health behavior generally, and no studies on weight loss specifically, one study examining the cognitive effects of supported versus unsupported dieting found significant interactions between measures of executive function and group assignment, such that individuals who were assigned to a supported dieting group exhibited better planning skills, as measured by the Tower of London (TOL) task (Green, Elliman, & Kretsch, 2005). Furthermore, in a study examining implications of Temporal Self-Regulation Theory principles on health behavior among undergraduates, Booker & Mullan (2013) found that individuals who felt supported by their environment demonstrated greater success in adhering to healthy behaviors (e.g., physical activity, sleep, healthy eating), compared to those who felt unsupported. Our own findings are in line with these results and support the need to assess individual cognitive factors within the environmental/interpersonal support contexts in which they are utilized. Additionally, our findings build upon prior results by highlighting the complex interaction between a specific domain of cognitive function (i.e., executive skills) and a specific type of environmental support (i.e., spousal support and household structure).

We found two notable exceptions to the more consistent pattern that strong executive skills in high support environments lead to greater weight loss. When examining interactions between support and the D-KEFS inhibition measure, as well as support and the BRIEF-A Working Memory subscale, results indicated that at high levels of support, stronger executive skills were either not associated with weight loss or were associated with less weight loss, while at low levels of support, stronger executive skills were associated with greater weight loss. Again, there is little existing research that examines such interactions, however, Booker & Mullan (2013) also report that self-regulation (executive functioning), was only predictive of healthy behaviors among undergraduates who felt unsupported by their environment. This pattern of findings suggests that perhaps, certain executive functions are utilized more when environmental supports are low, and participants feel a greater need to rely on their own individual cognitive resources.

It is not immediately clear why stronger self-reported Working Memory skills would be associated with less weight loss even in the context of a high support environments. It is possible that confounding factors, such as emerging symptoms of depression and anxiety, not monitored over the course of the intervention, selectively impacted participants' perceived working memory skills. There is some literature to suggest that working memory is selectively impacted by increased cortico-steriod release in response to stressors (Green et al., 2005; Lupien, Gillin, & Hauger, 1999). Another possibility is that example behaviors provided in the BRIEF-A Working Memory subscale are less related to weight-loss specific behaviors.

Finally, we examined interactions between executive skills and levels of household chaos reported by participants. None of the objective measures of executive function interacted with household chaos to predict weight loss or maintenance, yet several significant interactions were detected between self-report subscales and household chaos. Results suggest that, in general, strong executive skills are beneficial regardless of the level of household chaos. None of our findings suggested that strong executive skills interacted with household chaos to predict lower weight loss.

The construct of household chaos, specifically, is an understudied area in the adult weight loss and maintenance literature, however, research on the influence of structure, broadly, indicates that routine eating patterns and implementing consistent meal times within the home has a positive impact on weight management (Lally, Wardle, & Gardner, 2011; Metzgar, Preston, Miller, & Nickols-Richardson, 2015; Wing & Phelan, 2005), while less structure can inhibit motivation and competence; crucial aspects of weight-related goal attainment. In considering our interaction results within the context of a behavioral weight loss intervention, it is important to note that structural supports, such as household organization or chaos, may function quite differently than interpersonal/spousal support when interacting with an individual's executive skills.

For example, in the present study, none of the objective executive function measures significantly interacted with household chaos, while several of the self-report measures did. This may be an indication that one's perception of their executive skills (or self-efficacy) may be a stronger predictor of weight loss outcomes in chaotic household environments than objective skill level. Additionally, none of the EF measures interacted with household chaos to predict weight loss maintenance, suggesting that structural support or environmental organization may be more important in the stages of initial weight loss, but less influential in sustaining weight loss over time. This consideration will be particularly useful in the development of future weight loss interventions that aim to implement multifaceted approaches to maintenance success, through both cognitive and environmental avenues.

Limitations

While this study contributes several novel and important findings to the extant literature, results should be interpreted in the context of study limitations. First, power was limited given the dyadic and interdependent nature of the data. Specifically, we had 80% power for our central regression analyses (alpha = .05) to detect a moderate effect size (d =.50) at the individual level, adjusting for interdependence. It is possible that lack of power contributed to inconsistent significant effects across models, particularly in the exploratory analyses detecting significant interactions between executive functions and environmental support variables.

In terms of study sample characteristics, couples in our study were primarily white, highly educated and economically stable couples, living in rural areas. Furthermore, baseline means of measures of partner support were relatively high. In considering variables that might deplete the limited amount of executive resources available to engage in health-behavior change, economic stability, neighborhood atmosphere, cognitive reserve, and feeling well-supported are crucial factors that allow individuals to dedicate cognitive resources to weight loss. Therefore, the results of our study may not be generalizable to all samples.

Regarding study design, because this was a sub-study implemented in the context of a larger weight loss intervention, the number of executive functions measured was limited to reduce participant burden. Future studies should aim to measure a broader range of executive skills, and utilize multiple measures that tap the same core executive skills (i.e., shifting, inhibition, and working memory). In this vein, objective measures of executive function utilized in this study were chosen from different test batteries that were normed on different demographic samples. To ensure consistency in test result interpretation, future studies should utilize tasks from the same batteries, normed on the same samples to the extent possible (i.e., Trail-Making tasks from the D-KEFS). Furthermore, we found no significant correlations between self-report measures and objective neuropsychological measures of executive function in the present study. This raises the important question of ecological validity of objective versus subjective measurement, particularly as interdisciplinary research continues to explore the bidirectional relationship between cognitive function and health behavior outcomes.

Additionally, although we screened for psychiatric conditions during the initial phone screen and excluded individuals who had a significant history of psychiatric illness, we did not include a stand-alone assessment of depression. Depression symptoms have the potential to adversely impact cognitive functioning (Ahern & Semkovska, 2017; Roca, Vives, Lopez-Navarro, Garcia-Campayo, & Gili, 2015; Rock, Roiser, Riedel, & Blackwell, 2014), and have been found to mediate the relationship between obesity and select executive skills (Cserjési, Luminet, Poncelet, & Lénárd, 2009). Depression symptoms that were not reported at intake or emerged over the course of the intervention are, therefore, an important potential confound to consider in interpreting our findings.

Finally, the impact of physical activity on improvement in cognitive functioning is well-documented (Chan et al., 2013; Daly et al., 2015; Hayes, et al., 2014; McAuley et al., 2013) and should not be overlooked. Our analyses did not control for levels of physical activity to maintain parsimony within model variance, because objective measures (i.e., pedometers) of activity were not utilized in this intervention, and because all participants, regardless of group assignment, were prescribed the same exercise regimen. Future studies should ideally use a combination of self-monitored or self-reported physical activity data in conjunction with objective activity trackers to 1) compare potential differences between both methods, 2) capture more objective measures of activity among participants, and 3) more concretely address the ways in which cognitive function and physical activity impact one another in a weight loss program.

Conclusions

In summary, this study contributes important findings to the extant literature on the role of executive functions in successful weight management. We have corroborated prior research indicating that certain executive functions predict weight loss success, and have done so in the context of a longitudinal behavioral weight loss program. Furthermore, we contribute novel findings and build on the current literature base in several ways that hold noteworthy implications for clinical intervention; 1) we identified important cognitive predictors not only of weight loss but, crucially, weight loss maintenance by measuring executive functions longitudinally and conducting a 6-month, post intervention assessment of maintenance success, 2) we demonstrated that executive functions, implicated in initial weight loss and sustained health-behavior change, have the potential to improve in the context of a behavioral weight loss intervention, and 3) we conducted exploratory analyses that begin to elucidate the complex interactions between individual cognitive factors and environmental support systems that may lead to greater weight loss and maintenance outcomes.

Additional research is clearly needed to further elucidate the active ingredients in behavioral interventions that may serve to improve executive skills. Furthermore, future work must parse apart more consistent patterns in cognitive function and environmental support interactions that might lead to improved intervention designs and the dilemma of successful weight loss maintenance. Finally, research should also continue to explore the efficacy of executive function training programs (Dassen, Houben, Van Breukelen, & Jansen, 2018; Forman et al., 2018; Hayes, Eichen, Barch, & Wilfley, 2018; Jones et al., 2018; Hardman, Lawrence, & Field, 2018; Verbeken, Braet, Goossens, & van der Oord, 2013; Zoltak, Veling, Chen, & Holland, 2018), particularly with individuals living with overweight or obesity, to bolster cognitive resources available to engage in long term health-behavior change.

Appendix A. Tables

Table 1

Demographics of the study sample by intervention group, reported by mean (SD) or N (%)

		BWL (*N*=68; 34 couples)	SDT-WL (*N*=58; 29 couples)
Age		52.81 (10.42)	54.00 (9.75)
Sex	*Male*	34 (50.0%)	29 (50.0%)
	Female	34 (50.0%)	29 (50.0%)
Marital Status	*Married*	66 (96.8%)	56 (97.0%)
	Unmarried Couple	2 (2.9%)	2 (3.4%)
Same-Sex Couple[a]	*Yes*	0 (0.0%)	2 (6.9%)
	No	34 (100%)	27 (93.1%)
Race	*White*	56 (90.3%)	62 (93.9%)
	Black	3 (4.4%)	1 (1.7%)
	Asian	3 (4.4%)	1 (1.7%)
	Hispanic/Latino	0 (0.0%)	2 (3.4%)
Education	*Bachelor's Degree*	17 (24.2%)	10 (16.7%)
	Graduate or Professional Degree	23 (33.9%)	25 (42.4%)
Income	*$75,000 or above*	51 (75.0%)	47 (81.5%)
Baseline Height (cm)		169.94 (9.70)	170.89 (9.84)
Baseline Weight (kg)		96.40 (20.73)	99.50 (19.27)
Percent Weight Change (6 months)		-10.80 (6.81)	-10.40 (6.74)
Percent Weight Change (12 months)		-8.56 (8.81)	-9.60 (8.11)

Significant differences between groups on age, height, weight, and weight change were tested using multilevel univariate mixed models; *p < .05, **p < .01.

[a]Reported at the level of the dyad.

Note: For percent weight change at 6 months *N*=117, and 12 months *N*=103.

Table 2

Descriptive statistics for primary executive function variables

Measures	Baseline (N=122)	6 Month (N=120)
Neuropsychological Tasks	Mean (SD)	Mean (SD)
Trails A	28.94 (10.4)	25.71 (8.2)
Trails B	71.92 (34.0)	64.72 (25.2)
Color-Word Inhibition	60.97 (22.3)	54.65 (13.2)
Letter Fluency	40.14 (11.0)	41.38 (11.2)
Category Fluency	41.85 (8.8)	43.0 (9.4)
Self-Report	Baseline (T-scores)	6 Month (T-Scores)
BRIEF Inhibit	51.84 (8.4)	51.00 (9.5)
BRIEF Shift	54.63 (9.4)	53.00 (9.4)
BRIEF Emotional Control	53.00 (10.5)	51.00 (10.8)
BRIEF Self Monitor	50.66 (9.1)	49.39 (10.4)
BRIEF Initiate	53.48 (9.0)	50.38 (8.8)
BRIEF Working Memory	55.65 (11.0)	52.91 (11.2)
BRIEF Plan/Organize	53.16 (9.5)	51.80 (9.6)
BRIEF Task Monitor	56.01 (9.1)	53.53 (10.1)
BRIEF Organize Materials	55.12 (10.6)	52.23 (10.1)

Note: Trails A, Trails B, and D-KEFS Color-Word conditions measured in seconds; D-KEFS Verbal and Category Fluency scores are total correct responses. BRIEF subscales are reported as T-scores. Scales are a 3- point Likert-type from 1 = “never problematic” to 3 = “often problematic”. Higher scores indicate greater difficulty.

Table 3
Descriptive statistics of support and home environment variables for the overall sample reported as mean (standard deviation).

Measures	Baseline M (SD)	3 month M (SD)	6 month M (SD)
Partner Support			
Autonomy Support	5.65 (1.04)	6.25 (0.72)	6.23 (0.85)
Directive Support	3.35 (1.56)	4.09 (1.34)	3.93 (1.45)
Home Environment	Sum (SD)		Sum (SD)
CHAOS	47.85 (8.10)	--	47.36 (7.40)

Note: For support, *N* at 3 months =119, 6 months *N*=121, and 12 months *N*=109. Scores for the CHAOS are calculated as the sum of the 15 items.

Table 4
Correlation matrix of demographic variables and percent weight loss at 6 months, 12 months, and maintenance (calculated as % weight change from 6 months to 12 months).

	1	2	3	4	5	6	7	8	9
1. % WL 6 mo.	--	.922**	.233*	.029	-.061	-.050	-.096	-.196*	-.106
2. % WL 12 mo.		--	.592**	-.065	-.077	-.036	-.033	-.135	-.091
3. Maintenance			--	-.086	-.047	.011	.025	.066	-.023
4. Group				--	.000	.062	.056	.115	.073
5. Gender					--	-.059	-.022	-.036	-.098
6. Age						--	.091	.105	-.113
7. Ed.							--	.578**	-.058
8. IQ								--	-.040
9. BMI BL									--

Note: BMI = body mass index; WL = weight loss; BL= baseline
*** Correlation is significant at 0.01 level (2-tailed)*
** Correlation is significant at the 0.05 level (2-tailed)*

Table 5

Correlation matrix of baseline executive function variables and percent weight loss at 6 months, 12 months, and maintenance (calculated as % weight change from 6 months to 12 months).

Note: BMI = body mass index; WL = weight loss; BL= baseline, C-W = Color-Word

	1	2	3	4	5	6	7	8	9	10	11	12
1. Group	--	.073	.029	-.065	-.086	.115	-.066	.045	-.075	.150	-.012	.063
2. BMI BL		--	-.142	-.102	-.021	.001	.078	.108	.136	.083	-.152	.020
3. % WL 6 mo			--	.921**	.254*	-.182	.033	.005	-.139	-.032	.188	.192*
4. % WL 12 mo				--	.611**	-.132	.075	.014	-.075	-.012	.214*	.243*
5. Maintenance					--	.050	-.107	-.088	.022	.002	.197	.175
6. IQ						--	-.066	-.076	.257**	.093	-.064	-.262**
7. C-W Inhibition							--	.627**	-.317**	-.261**	.213*	.289**
8. C-W Switch								--	-.187*	-.227*	.202*	.374**
9. Letter Flue.									--	.384**	-.295**	-.275**
10. Category Flue.										--	-.182	-.096
11. Trails A											--	.241**
12. Trails B												--

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 6

Correlation matrix of 6-month executive variables and % weight loss at 6 months, 12 months, and maintenance (calculated as % weight change from 6 months to 12 months).

	1	2	3	4	5	6	7	8	9	10	11
1. BMI BL	--	-.142	-.102	-.021	.001	-.088	-.068	.266**	.111	-.171	-.120
2. % WL 6 mo.		--	.921**	.254*	-.182	-.160	.050	-.128	-.045	.112	.131
3. % WL 12 mo.			--	.611**	-.132	-.132	.091	-.027	.017	.106	.127
4. Maintenance.6				--	.050	.068	.079	.051	-.018	.101	.071
5. IQ.6					--	.199*	.209*	.208*	.132	-.044	-.291**
6. C-W Inhibit.6						--	.471**	.234*	.216*	-.201*	-.392**
7. C-W Switch.6							--	.129	.185	-.194*	-.363**
8. Verbal Flue.6								--	.478**	-.232*	-.252**
9. Category Flue.6									--	-.241*	-.195*
10. Trails A.6										--	.490**
11. Trails B.6											--

Note: BMI = body mass index; WL = weight loss; BL= baseline, C-W = Color-Word

*** Correlation is significant at the 0.01 level (2-tailed).*

** Correlation is significant at the 0.05 level (2-tailed).*

Table 7

Correlation matrix of baseline BRIEF-A subscales and % weight loss at 6 months, 12 months, and maintenance (calculated as % weight change from 6 months to 12 months).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Group	--	.073	.029	-.065	-.086	.009	.079	-.032	-.058	.059	-.008	.043	.064	.000
2. BMI BL		--	-.106	-.091	-.023	-.032	-.087	-.025	-.003	-.025	-.064	-.093	-.055	-.179
3. % WL 6 mo.			--	.922**	.233*	.113	.157	.190*	.215*	.133	.141	.194*	.091	.084
4. % WL 12 mo.				--	.592**	.195	.138	.156	.220*	.151	.145	.191	.077	.079
5. Maintenance					--	.163	.084	.035	.239*	.228*	.116	.168	.041	.093
6. BRIEF-A Inhibit						--	.471**	.417**	.549**	.385**	.571**	.576**	.534**	.405**
7. BRIEF-A Shift							--	.582**	.461**	.562**	.611**	.696**	.481**	.355**
8. BRIEF-A Emotional Control								--	.527**	.447**	.495**	.467**	.373**	.223*
9. BRIEF-A Self Monitor									--	.550**	.516**	.487**	.479**	.312**
10. BRIEF-A Initiate										--	.585**	.668**	.511**	.417**
11. BRIEF-A Working Memory											--	.684**	.625**	.477**
12. BRIEF-A Plan/Org.												--	.639**	.485**
13. BRIEF-A Task Monitor													--	.501**
14. BRIEF-A Org.Materials														--

Note: BMI = body mass index; WL = weight loss; BL= baseline

*** Correlation is significant at the 0.01 level*

** Correlation is significant at the 0.05 level*

Table 8

Correlation matrix of 6-month BRIEF-A subscales and % weight loss at 6 months, 12 months, and maintenance (calculated as % weight change from 6 months to 12 months).

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. BMI BL	--	-.106	-.091	-.023	.045	-.059	-.126	-.050	.045	-.100	-.135	-.107	-.080
2. % WL 6 mo.		--	.922**	.233*	.232*	.259**	.243**	.255**	.198*	.158	.224*	.125	.124
3. % WL 12 mo.			--	.592**	.205*	.239*	.184	.277**	.178	.176	.198*	.133	.077
4. Maintenance				--	.060	.128	.034	.126	.104	.158	.160	.102	.048
5. BRIEF-A Inhibition (6)					--	.519**	.516**	.656**	.488**	.721**	.546**	.591**	.404**
6. BRIEF-A Shifting (6)						--	.610**	.554**	.594**	.600**	.624**	.566**	.326**
7. BRIEF-A Emotional Control (6)							--	.632**	.473**	.558**	.433**	.426**	.270**
8. BRIEF-A Self Monitor (6)								--	.484**	.706**	.538**	.589**	.400**
9. BRIEF-A Initiate (6)									--	.646**	.687**	.595**	.529**
10. BRIEF-A Working Memory (6)										--	.703**	.721**	.565**
11. BRIEF-A Plan/Organize (6)											--	.715**	.569**
12. BRIEF-A Task Monitor (6)												--	.521**
13. BRIEF-A Organize Materials (6)													--

Note: BMI = body mass index; WL = weight loss; BL= baseline

*** Correlation is significant at the 0.01 level*

** Correlation is significant at the 0.05 level*

Table 9

Correlation matrix of baseline executive function variables and environmental variables (autonomy support, directive support and household CHAOS) measured at baseline, 3, and 6 months.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Group	--	.12	-.02	.05	-.08	.15	.01	.06	-.01	-.10	-.18	-.01	-.13	-.07	.05	-.10
2. IQ		--	-.06	-.07	.26**	.09	-.06	-.26**	-.08	-.17	.06	-.02	-.17	.13	.09	-.04
3. C-W Inhibition			--	.63**	-.32**	-.26**	.21*	.29**	-.12	.20*	-.04	-.20*	.12	-.06	-.09	.06
4. C-W Switch				--	-.19*	-.23*	.20*	.37**	-.20*	.03	-.09	-.25**	.03	-.06	-.06	-.02
5. Letter Flue					--	.38**	-.29**	-.28**	.20*	-.11	.17	.29**	-.20*	.11	.28**	-.24*
6. Category Flue						--	-.18	-.10	.03	-.14	.01	.18	-.11	.06	.13	-.19*
7. Trails A							--	.24**	-.10	.22*	-.06	-.16	.10	-.15	-.27**	.08
8. Trails B								--	-.11	.15	-.06	-.14	.04	.02	-.28**	-.05
9. Autonomy Support (AS)									--	.21*	.25**	.51**	.04	.05	.42**	.11
10. Directive Support (DS)										--	.14	.02	.47**	.03	-.07	.55**
11. CHAOS											--	.27**	-.10	.33**	.22*	.01
12. AS (3)												--	.16	.11	.61**	.07
13. DS (3)													--	-.07	.09	.78**
14. CHAOS (6)														--	.09	-.06
15.AS (6)															--	.15
16. DS (6)																--

Note: BMI = body mass index; WL = weight loss; BL= baseline; AS = autonomy support;
DS = directive support, CHAOS = household chaos, C-W = Color-Word
*** Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*

Table 10

Correlation matrix of executive function variables at 6 months and environmental variables (autonomy support, directive support and household CHAOS) measured at baseline, 3, and 6 months.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. C-W Inhibit.6	--	.56**	-.21*	-.19*	.30**	.48**	-.23*	.20*	-.10	-.21*	.16	-.09	-.14	-.00
2. C-W Switch.6		--	-.11	-.18	.26**	.45**	-.14	.11	-.06	-.15	.06	-.08	-.07	-.01
3. Verbal F.6			--	.48**	-.23*	-.25**	.19*	-.03	.27**	.29**	-.09	.17	.13	-.12
4. Category F.6				--	-.24*	-.20*	.12	-.23*	.26**	.22*	-.15	.19*	.22*	-.22*
5. Trails A.6					--	.49**	-.02	.17	.03	-.12	.09	-.15	-.20*	.02
6. Trails B.6						--	.02	.16	-.05	.02	.21*	-.04	-.08	.07
7. Autonomy Support (AS)							--	.21*	.25**	.51**	.04	.05	.42**	.11
8. Directive Support (DS)								--	.14	.02	.47**	.03	-.07	.55**
9. CHAOS									--	.27**	-.10	.33**	.22*	.01
10. AS (3)										--	.16	.11	.61**	.07
11. DS (3)											--	-.07	.09	.78**
12. CHAOS (6)												--	.09	-.06
13. AS (6)													--	.15
14. DS (6)														--

Note: BMI = body mass index; WL = weight loss; BL= baseline; AS = autonomy support; DS = directive support, C-W = Color-Word
*** Correlation is significant at the 0.01 level.*
** Correlation is significant at the 0.05 level.*

Table 11

Correlation matrix of baseline BRIEF-A subscales and environmental variables (autonomy support, directive support, and household CHAOS) measured at baseline, 3, and 6 months.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Group	--	.009	.079	-.032	-.058	.059	-.008	.043	.064	.000	-.009	-.103	-.013	-.130	-.052	-.096	-.175	-.172
2. BRIEF-A Inhibition		--	.471**	.417**	.549**	.385**	.571**	.576**	.534**	.405**	-.061	-.044	-.025	.060	-.052	-.055	-.049	-.181
3. BRIEF-A Shifting			--	.582**	.461**	.562**	.611**	.696**	.481**	.355**	-.133	.062	-.142	-.004	-.134	.018	-.193*	-.264**
4. BRIEF-A Emotional Control				--	.527**	.447**	.495**	.467**	.373**	.223*	-.118	.071	-.087	.125	-.075	.058	-.114	-.183
5. BRIEF-A Self-Monitor					--	.550**	.516**	.487**	.479**	.312**	-.168	.087	-.208*	.120	-.174	.085	.041	-.116
6.BRIEF-A Initiate						--	.585**	.668**	.511**	.417**	-.132	.011	-.122	.001	-.138	-.017	-.088	-.070
7. BRIEF-A Working Memory							--	.684**	.625**	.477**	-.048	.065	-.111	-.040	-.148	-.076	-.127	-.109
8. BRIEF-A Plan/Organize								--	.639**	.485**	-.181*	-.001	-.129	-.059	-.110	-.047	-.158	-.148
9. BRIEF-A Task Monitor									--	.501**	-.111	-.017	-.139	-.134	-.079	-.121	-.139	-.124
10. BRIEF-A Org. Materials										--	-.067	-.092	-.019	-.010	-.075	-.046	-.256**	-.227*
11. Autonomy Support (AS)											--	.152	.550**	.033	.498**	.128	.166	.121
12. Directive Support (DS)												--	-.014	.466**	-.141	.520**	.153	-.016
13. AS (3)													--	.136	.634**	.082	.190*	.181
14. DS (3)														--	.069	.771**	-.079	-.085
15. AS (6)															--	.176	.072	.187*
16. DS (6)																--	.028	-.039
17. CHAOS																	--	.281**
18. CHAOS (6)																		--

Note: AS = autonomy support, DS = directive support, CHAOS = household chaos

*** Correlation is significant at the 0.01 level*

** Correlation is significant at the 0.05 level*

Table 12

Correlation matrix of BRIEF-A subscales at 6 months and environmental variables (autonomy support, directive support, and household CHAOS) at baseline, 3, and 6 months.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.BRIEF-A Inhibition	--	.471**	.417**	.549**	.385**	.571**	.576**	.534**	.405**	-.061	-.044	-.025	.060	-.052	-.055	-.049	-.181
2. BRIEF-A Shifting		--	.582**	.461**	.562**	.611**	.696**	.481**	.355**	-.133	.062	-.142	-.004	-.134	.018	-.193*	-.264**
3. BRIEF-A Emot. Cntrl			--	.527**	.447**	.495**	.467**	.373**	.223*	-.118	.071	-.087	.125	-.075	.058	-.114	-.183
4. BRIEF-A Self-Mon.				--	.550**	.516**	.487**	.479**	.312**	-.168	.087	-.208*	.120	-.174	.085	.041	-.116
5. BRIEF-A Initiate					--	.585**	.668**	.511**	.417**	-.132	.011	-.122	.001	-.138	-.017	-.088	-.070
6. BRIEF-A Work Mem						--	.684**	.625**	.477**	-.048	.065	-.111	-.040	-.148	-.076	-.127	-.109
7. BRIEF-A Plan/Org.							--	.639**	.485**	-.181*	-.001	-.129	-.059	-.110	-.047	-.158	-.148
8. BRIEF-A Task Mon.								--	.501**	-.111	-.017	-.139	-.134	-.079	-.121	-.139	-.124
9. BRIEF-A Org. Mat.									--	-.067	-.092	-.019	-.010	-.075	-.046	-.256**	-.227*
10. Autonomy Support (AS)										--	.152	.550**	.033	.498**	.128	.166	.121
11. Directive Support (DS)											--	-.014	.466**	-.141	.520**	.153	-.016
12. AS (3)												--	.136	.634**	.082	.190*	.181
13. DS (3)													--	.069	.771**	-.079	-.085
14. AS (6)														--	.176	.072	.187*
15. DS (6)															--	.028	-.039
16. CHAOS																--	.281**
17. CHAOS (6)																	--

Note: AS = autonomy support, DS = directive support, CHAOS = household chaos

*** Correlation is significant at the 0.01 level*

** Correlation is significant at the 0.05 level*

Table 13

Regression Models Examining the Predictive Validity of Executive Function at Baseline on % Weight Loss at 6 months, 12 months, and Maintenance.

	6 month % WL		12 month % WL		Maintenance	
	B (*SE b*)	*p*	*B* (*SE b*)	*p*	*B* (*SE b*)	*p*
Model 1						
Group	.04 (.78)	.96	-.77 (1.1)	.47	-.45 (.47)	.34
BMI_{bl}	-.06 (.10)	.54	-.04 (.03)	.75	-.04 (.07)	.53
IQ	.04 (.06)	.55	.10 (.08)	.23	.07 (.04)	.09
Age	-.10 (.08)	.23	-.11 (.11)	.33	-.02 (.06)	.61
Trails A	.12 (.06)	.98	.16 (.07)	.07+	.06 (.04)	.12
Trails B	.05 (.02)	.01*	.07 (.03)	.01*	.03 (.02)	.03*
Model 2						
Group	.26 (.80)	.75	-.35 (1.1)	.75	-.34 (.49)	.49
BMI_{bl}	-.14 (.10)	.18	-.12 (.14)	.40	-.02 (.08)	.74
IQ	.00 (.06)	.95	.04 (.08)	.63	.04 (.04)	.39
Age	-.06 (.08)	.47	-.05 (.12)	.62	.02 (.06)	.65
D-KEFS Color-Word	.06 (.03)	.07+	.08 (.05)	.10	-.02 (.03)	.39
D-KEFS Inhibit/Switch	.00 (.04)	.95	.01 (.05)	.82	.03 (.03)	.33
Model 3						
Group	.10 (.79)	.90	-.66 (1.1)	.54	-.40 (.50)	.46
BMI_{bl}	.04 (.10)	.70	-.00 (.14)	1.0	-.02 (.07)	.78
IQ	-.01 (.06)	.90	-.01 (.08)	1.0	.03 (.43)	.43
Age	-.02 (.08)	.84	.03 (.11)	.80	.03 (.53)	.60
Letter Fluency	-.09 (.06)	.11	-.08 (.70)	.30	-0.1 (.04)	.75
Category Fluency	-.01 (.07)	.90	0.5 (.09)	.60	.01 (.05)	.83

Note: Values reported as unstandardized coefficients; BMI = body mass index; WL = weight loss; BL= baseline

*** Correlation is significant at 0.01 level*

** Correlation is significant at the 0.05 level*

Table 14

Regression Models Examining the Predictive Validity of BRIEF-A Subscales at Baseline on % Weight Loss at 6 months, 12 months, and Maintenance.

	6 month % WL		12 month % WL		Maintenance	
	B (*SE b*)	*p*	*B* (*SE b*)	*p*	*B* (*SE b*)	*p*
Model 1						
Group	.03 (.88)	1.00	-.90 (1.1)	.44	-.08(.49)	.88
BMI.0	-.01 (.12)	-.09	-.02 (.15)	.90	.02 (.07)	.76
IQ	.07 (.07)	.31	.16 (.10)	.11	.02 (.04)	.59
Age	-0.5 (.10)	.57	-.01 (.12)	.94	.02 (.05)	.75
BRIEF-A Shifting	.06 (.09)	.52	.01 (.11)	.90	-.06 (.05)	.24
BRIEF-A Inhibit	-.01 (.11)	.93	.08 (.14)	.59	.14 (.06)	.03*
BRIEF-A Emotional Control	-.02 (.07)	.74	-.03 (.08)	.70	-.03 (.04)	.44
BRIEF-A Self-Monitor	.08 (.09)	.86	.13 (.11)	.27	.06 (.05)	.28
BRIEF-A Planning	.03 (.34)	.25	-.04 (.14)	.78	-.01 (.06)	.88
BRIEF-A Initiate	.02 (.11)	.65	.07 (.14)	.65	.14 (.06)	.04*
BRIEF-A Working Memory	.05 (.08)	.91	.16 (.11)	.16	.01 (.05)	.80
BRIEF_A Task Monitor	.03 (.10)	.31	-.09 (.14)	.53	-.14 (.06)	.03*
BRIEF-A Organize Materials	-.07 (.08)	-1.00	-.09 (.10)	.78	.03 (.04)	.55

Table 15

Regression Analyses Examining Changes in Executive Function Measures from Baseline to 6-Months (N=120)

	B	*t*	*p*
Neuropsychological Tasks			
Trails A	-3.29	-3.66	<.01*
Trails B	-5.24	-1.83	.07
D-KEFS Color-Word	-1.93	-2.17	.03*
D-KEFS Inhibit/Switch	-5.45	-3.13	.01*
Verbal Fluency	.42	.65	.72
Category Fluency	.77	.65	.52
Self-Report			
BRIEF Inhibit	.62	1.00	.32
BRIEF Shift	1.58	2.00	.06+
BRIEF Emotional Control	2.05	2.49	.02*
BRIEF Self Monitor	1.70	2.30	.03*
BRIEF Initiate	3.63	4.66	<.01*
BRIEF Working Memory	2.40	3.00	.01*
BRIEF Plan/Organize	1.54	2.04	.05*
BRIEF Task Monitor	2.70	3.71	<.01*
BRIEF Organize Materials	2.88	4.16	<.01*

Table 16

Regression Analyses Examining Predictive Validity of Changes in Executive Function Measures on Percent Weight Loss at 6 months, 12 months and Maintenance

	6 month WL			12 month WL			Maintenance		
	B	*t*	*p*	*B*	*t*	*p*	*B*	*t*	*p*
Neuropsychological Measures									
Trails A Δ	-.05	-.75	.45	-.09	-1.04	.30	-.04	-1.05	.30
C-W Inhibition Δ	.00	.04	1.0	-.01	-.27	.79	.01	.33	.75
C-W Inhibit/Switch Δ	-.03	-.68	.50	-.07	-1.29	.20	-.01	-.50	.66
Self-Report									
BRIEF Emotional Control Δ	-.10	-.39	.70	.30	1.03	.31	.03	.24	.81
BRIEF Self Monitor Δ	-.62	-1.54	.13	-1.28	-2.50	.02*	-.10	-.36	.72
BRIEF Initiate Δ	-.15	-.41	.70	.08	.17	.90	.66	2.68	.01*
BRIEF Working Memory Δ	.24	.73	.47	.31	.80	.45	-.13	-.63	.53
BRIEF Plan/Organize Δ	.02	.08	.94	-.20	-.60	.55	-.12	-.70	.50
BRIEF Task Monitor Δ	.44	1.00	.34	.17	.33	.74	-.33	.21	.21
BRIEF Organize Materials Δ	-.36	-1.20	.23	-.33	-1.00	.35	.01	1.00	.98

** *Results significant at 0.01 level*

* *Correlation is significant at the 0.05 level*

Note: *C-W = Color-Word*; Only measures that were found to have significant change scores from baseline to 6 months were examined (e.g., Trails B, Verbal Fluency and Category Fluency, BRIEF Shift and BRIEF Inhibit scales are not reported).

Table 17

Percent weight loss at 6 months, 12 months and maintenance regressed onto baseline Trails A, Trails B, autonomy support, and their interaction terms

	Autonomy Support 3 months			Autonomy Support 6 months		
	B	*t*	*p*	*B*	*t*	*p*
Model 1						
PERCENT WEIGHT LOSS 6 MONTHS						
Step 1: Group	-.19	-.25	.81	.45	.54	.59
BMI	-.08	-.84	.40	-.14	-1.40	.17
IQ	.05	.80	.43	.01	.23	.82
Age	-.10	-1.24	.22	-.09	-1.10	.28
Step 2: Autonomy Support (baseline)	.20	.35	.73	.42	.81	.42
Autonomy Support (3 or 6)	-3.52	-.93	.36	-5.15	-1.51	.13
Trails A	-.06	-.11	.92	-.76	-1.50	.14
Trails B	-.10	-.37	.72	.13	.60	.55
Step 3: Autonomy Support X Trails A	.02	.24	.81	.13	1.65	.10
Autonomy Support X Trails B	.02	.57	.57	-.01	-.39	.70
Model 2						
PERCENT WEIGHT LOSS 12 MONTHS						
Step 3: Autonomy Support X Trails A	-.04	-.33	.75	.21	2.00	.05*
Autonomy Support X Trails B	.04	1.10	.28	-.01	-.25	.82
Model 3						
WEIGHT MAINTENANCE						
Step 3: Autonomy Support X Trails A	-.04	-.55	.60	.07	1.4	.16
Autonomy Support X Trails B	.03	1.14	.26	.01	.64	.53

*Note: Steps 2 and 3 for each subsequent model were the same as Model 1 and were excluded for redundancy.

Table 18

Percent weight loss at 6 months, 12 months and maintenance regressed onto baseline D-KEFS Inhibition, Autonomy Support, and their interaction terms.

	Autonomy Support 3 months			Autonomy Support 6 months		
	B	*t*	*p*	*B*	*t*	*p*
<u>Model 1</u>						
PERCENT WEIGHT LOSS 6 MONTHS						
Step 1: Group	.01	.00	1.0	.20	-2.60	.80
BMI (baseline)	-.10	-1.00	.32	-.17	-1.70	.09
IQ	.01	.15	.88	.01	.20	.84
Age	-.05	-.57	.56	-.05	-.58	.65
Step 2: Autonomy Support (baseline)	.21	-.44	.66	.45	.84	.40
Autonomy Support (3 or 6)	5.10	1.55	.13	7.73	2.50	.02*
D-KEFS Inhibit /Switch	-.02	-.45	.66	-.05	-1.25	.23
D-KEFS Inhibit	.75	2.15	.04*	1.18	3.43	<.01*
Step 3: Autonomy Support X D-KEFS Inhibit	-.11	-2.01	.05*	-.17	-3.30	<.01*
<u>Model 2</u>						
PERCENT WEIGHT LOSS 12 MONTHS						
Step 3: Autonomy Support X D-KEFS Inhibit	-.01	-.36	.72	-.10	-1.70	.09
<u>Model 3</u>						
WEIGHT MAINTENANCE						
Step 3: Autonomy Support X D-KEFS Inhibit	-.04	-1.0	.33	-.06	-1.52	.13

Table 19

Percent weight loss at 6 months, 12 months and maintenance regressed onto baseline Verbal Fluency, Category Fluency, Autonomy Support, and their interaction terms.

	Autonomy Support 3 months			Autonomy Support 6 months		
	B	*t*	*p*	*B*	*t*	*p*
Model 1						
PERCENT WEIGHT LOSS 6 MONTHS						
Step 1: Group	-.20	-.25	.80	.16	.20	.84
BMI (baseline)	-.09	-.90	.40	-.14	-1.40	.17
IQ	.12	.21	.83	-.01	-.20	.84
Age	-.05	-.57	.57	-.04	-.47	.64
Step 2: Autonomy Support (baseline)	.34	.55	.58	.56	.95	.35
Autonomy Support (3 or 6)	-.3.90	-1.07	.30	-6.13	-1.54	.13
Verbal Fluency	-.07	-.13	.90	-.19	-.34	.73
Category Fluency	-.41	-.60	.55	-.53	-.74	.50
Step 3: Autonomy Support X Verbal Fluency	-.01	-.05	1.0	.02	.20	.84
Autonomy Support X Category Fluency	.07	.65	.52	.09	.76	.45
Model 2						
PERCENT WEIGHT LOSS 12 MONTHS						
Step 3: Autonomy Support X Verbal Fluency	.05	.48	.64	-.07	-.68	.27
Autonomy Support X Category Fluency	.00	.02	1.0	.18	1.17	.25
Model 3						
WEIGHT MAINTENANCE						
Step 3: Autonomy Support X Verbal Fluency	.02	.31	.80	-.07	-1.44	.15
Autonomy Support X Category Fluency	-.07	-.78	.45	.02	.25	.80

Table 20

Percent weight loss at 6 months, 12 months and maintenance regressed onto baseline Trails A, Trails B, Autonomy Support at 3 months and 6 months, and their interaction terms.

	Directive Support 3 months			Directive Support 6 months		
	B	*t*	*p*	*B*	*t*	*p*
Model 1						
PERCENT WEIGHT LOSS 6 MONTHS						
Step 1: Group	.08	.12	.91	.11	.14	.89
BMI	-.12	-1.23	.22	-.10	-1.07	.29
IQ	.04	.80	.43	.05	.89	.38
Age	-.15	-2.0	.51	-.11	-1.36	.18
Step 2: Directive Support (baseline)	.68	2.80	.08	.45	1.10	.28
Directive Support (3 or 6)	1.01	.81	.42	-1.36	-1.08	.28
Trails A	.36	2.02	.05*	.03	.16	.87
Trails B	-.01	-.18	.86	-.02	-.27	.79
Step 3: Directive Support X Trails A	-.06	-1.58	.12	.02	.42	.68
Directive Support X Trails B	.02	1.13	.26	.02	1.28	.20
Model 2						
PERCENT WEIGHT LOSS 12 MONTHS						
Step 3: Directive Support X Trails A	-.12	-2.36	.02*	-.01	-.16	.88
Directive Support X Trails B	.01	.84	.41	.02	1.0	.33
Model 3						
WEIGHT MAINTENANCE						
Step 3: Directive Support X Trails A	-.05	-1.85	.07	-.04	-1.40	.17
Directive Support X Trails B	-.01	-.12	.91	.01	1.16	.25

Table 21

Percent weight loss at 6 months, 12 months and maintenance regressed onto baseline D-KEFS inhibition and inhibition/switching, directive support at 3 months and 6 months, and their interaction terms.

	Directive Support 3 months			Directive Support 6 months		
	B	*t*	*p*	*B*	*t*	*p*
<u>Model 1</u>						
PERCENT WEIGHT LOSS 6 MONTHS						
Step 1: Group	.02	.04	1.0	.42	.52	.60
BMI (baseline)	-.17	-1.61	.11	-.19	-1.75	.08
IQ	.02	.27	.79	-.01	-.32	.90
Age	-.08	-1.0	.33	-.05	-.63	.53
Step 2: Directive Support (baseline)	.89	2.15	.66	.64	1.45	.15
Directive Support (3 or 6)	-1.20	-.90	.37	.52	.38	.70
D-KEFS Inhibit /Switch	-.00	-.04	1.0	-.01	-.17	.87
D-KEFS Inhibit	-.06	-.67	.50	.05	.50	.62
Step 3: Directive Support X D-KEFS Inhibit	0.22	1.09	.28	-.00	-.17	.87
<u>Model 2</u>						
PERCENT WEIGHT LOSS 12 MONTHS						
Step 3: Directive Support X D-KEFS Inhibit	.02	1.0	.32	.04	1.30	.20
<u>Model 3</u>						
WEIGHT MAINTENANCE						
Step 3: Directive Support X D-KEFS Inhibit	-.01	-.65	.52	.02	1.20	.23

Table 22

Percent weight loss at 6 months, 12 months and maintenance regressed onto baseline verbal fluency, category fluency, directive support at 3 months and 6 months, and their interaction terms.

	Directive Support 3 months			Directive Support 6 months		
	B	*t*	*p*	*B*	*t*	*p*
Model 1						
PERCENT WEIGHT LOSS 6 MONTHS						
Step 1: Group	-.25	-.33	.74	.20	.24	.80
BMI (baseline)	-.13	-1.26	.21	-.16	-1.50	.14
IQ	.02	.37	.71	.00	-.01	1.0
Age	-.05	-.61	.54	-.04	-.48	.64
Step 2: Directive Support (baseline)	1.0	2.43	.02	.77	1.71	.09
Directive Support (3 or 6)	4.51	1.74	.09	2.0	.86	.39
Verbal Fluency	.02	.14	.89	-.11	-.67	.50
Category Fluency	.39	1.51	.13	.24	1.06	.29
Step 3: Directive Support X Verbal Fluency	-.03	-.69	.49	.01	.20	.84
Directive Support X Category Fluency	-.08	-1.34	.17	-.05	-1.03	.31
Model 2						
PERCENT WEIGHT LOSS 12 MONTHS	-0.2	-1.60	.12	-.02	-1.27	.21
Step 3: Directive Support X Verbal Fluency						
Directive Support X Category Fluency	.12	1.41	.16	.01	.94	.35
Model 3						
WEIGHT MAINTENANCE						
Step 3: Directive Support X Verbal Fluency	-.00	-.17	.86	-.01	-1.15	.25
Directive Support X Category Fluency	-.00	.00	1.00	-.00	-.17	.87

Appendix B. Figures

Figure 1

Conceptual model of the impact of executive function on successful weight control. The model outlines the potential role of executive functions as moderators of specific behaviors implicated in two distinct phases of weight management: 1) Initial weight loss and 2) weight loss maintenance (Gettens & Gorin, 2017).

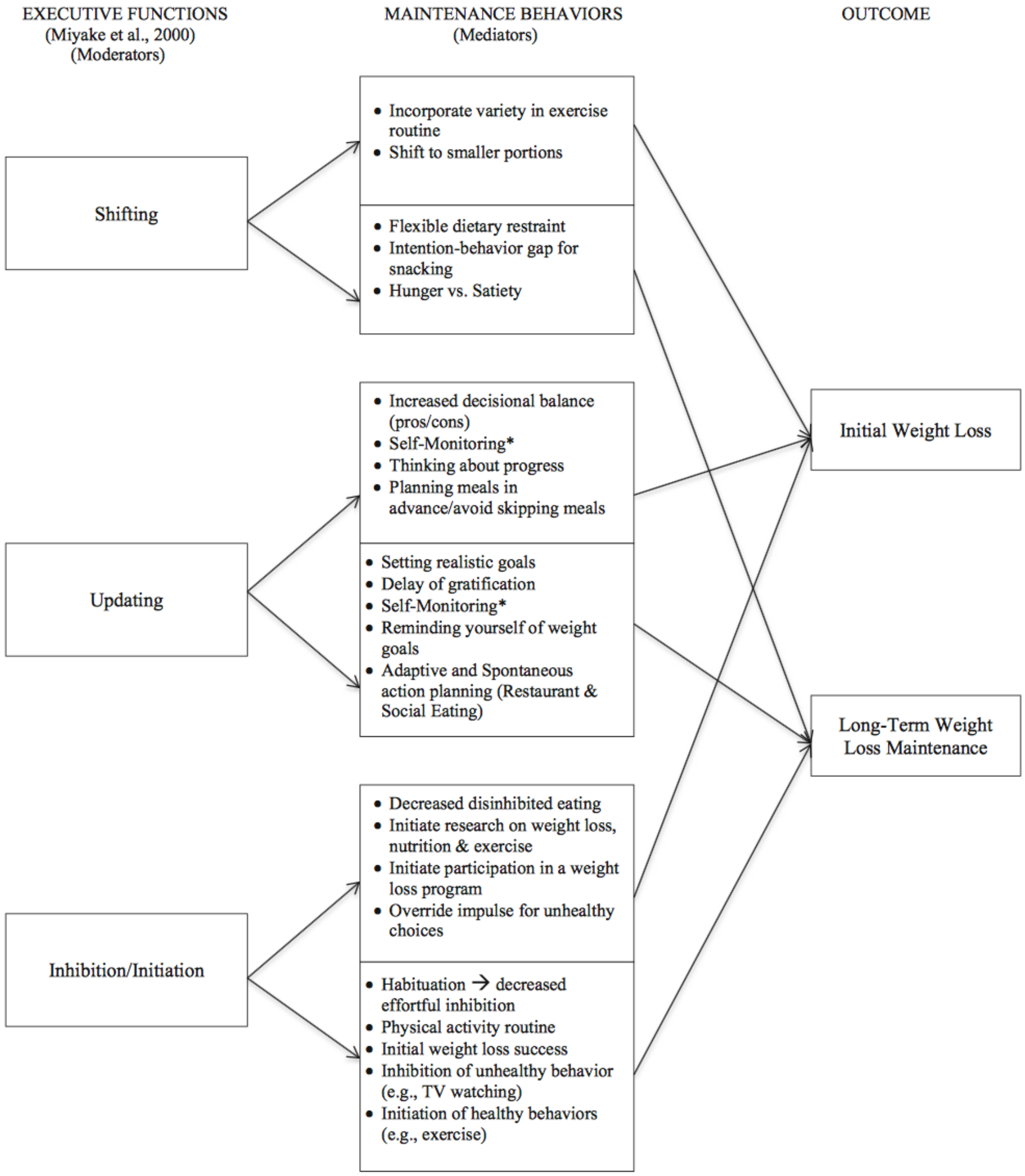
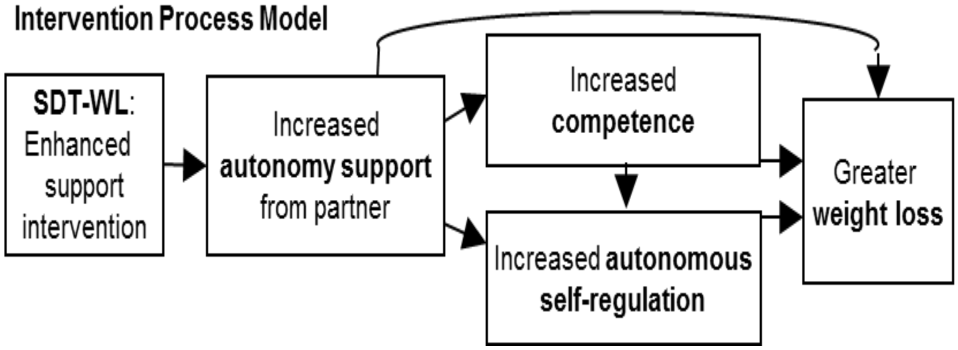


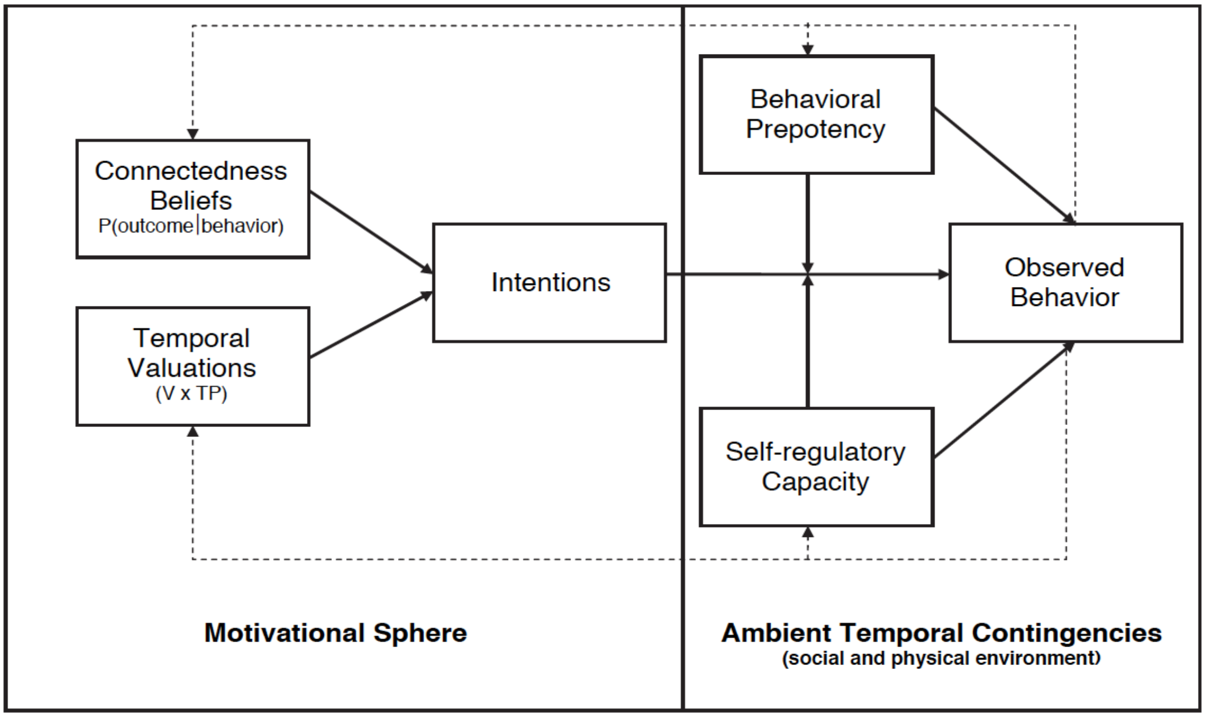
Figure 2

Self-Determination Theory Process Model



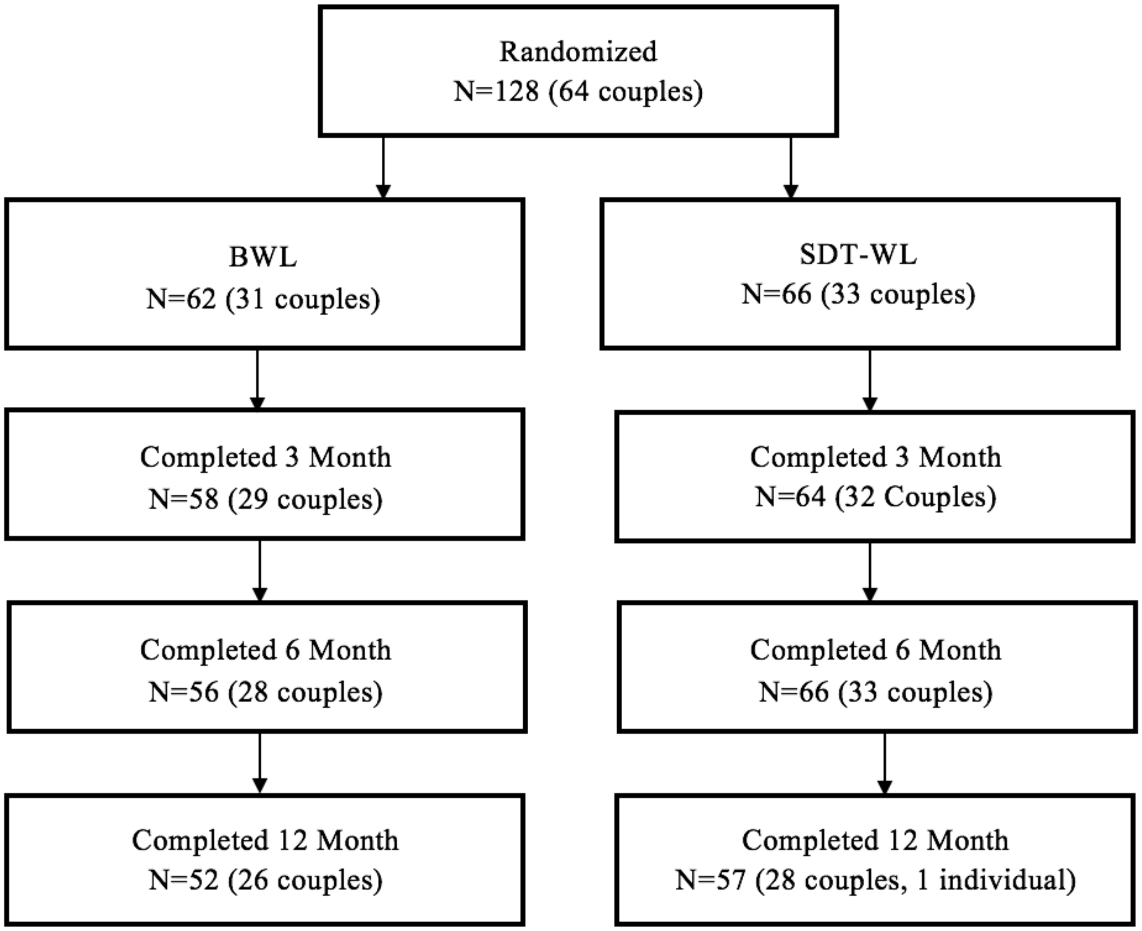
Intervention process model based on Self-Determination Theory (SDT) principles (Deci & Ryan, 2008).

Figure 3
Temporal Self-Regulation Theory Process Model



Temporal self-regulation theory process model, incorporating both environmental factors (i.e., habits, norms) and executive functions (e.g., inhibition, working memory, flexibility) as moderators of the intention behavior gap (Hall & Fong, 2007, 2015).

Figure 4
CONSORT Diagram of Overall Study Sample



Study flow for *N*=128 randomized couples. A total of 5 couples dropped out in the BWL condition, and 4 couples plus 1 individual in SDT-WL. *Note:* One couple did not complete the 3-month assessments for SDT-WL but returned for 6- and 12-month assessments.

Figure 5
Nested Design for Multilevel Modeling (MLM) Analyses

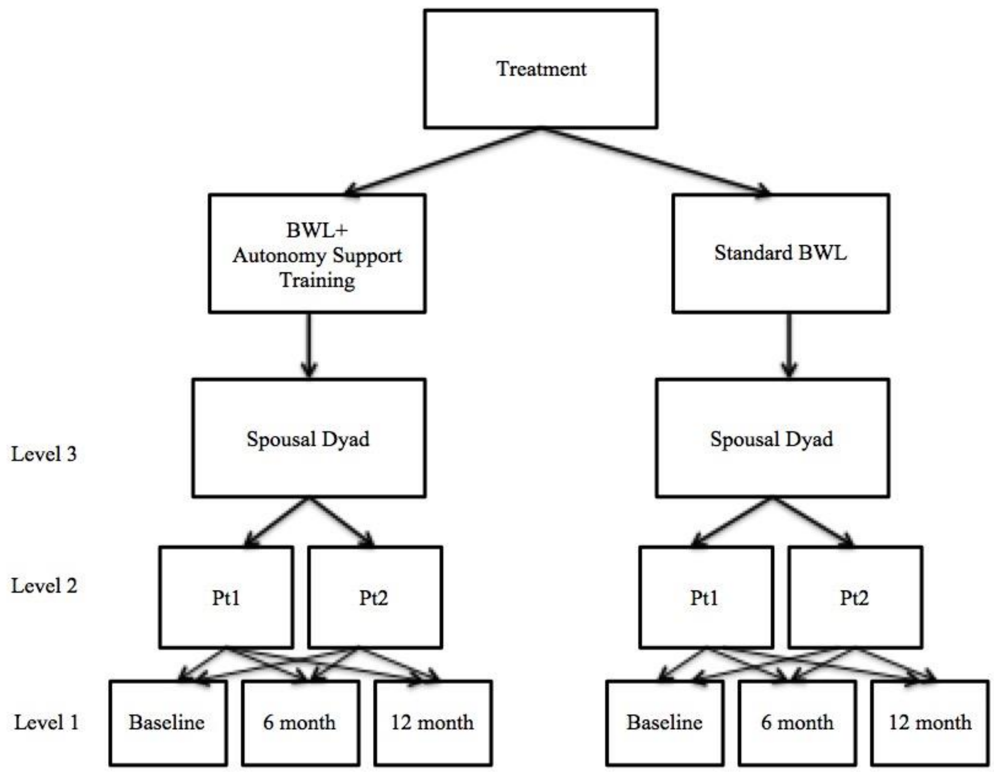


Figure 6

Simple slopes depicting the interaction between D-KEFS Color-Word Inhibition performance and autonomy support at 3 months on percent weight loss at 6 months.

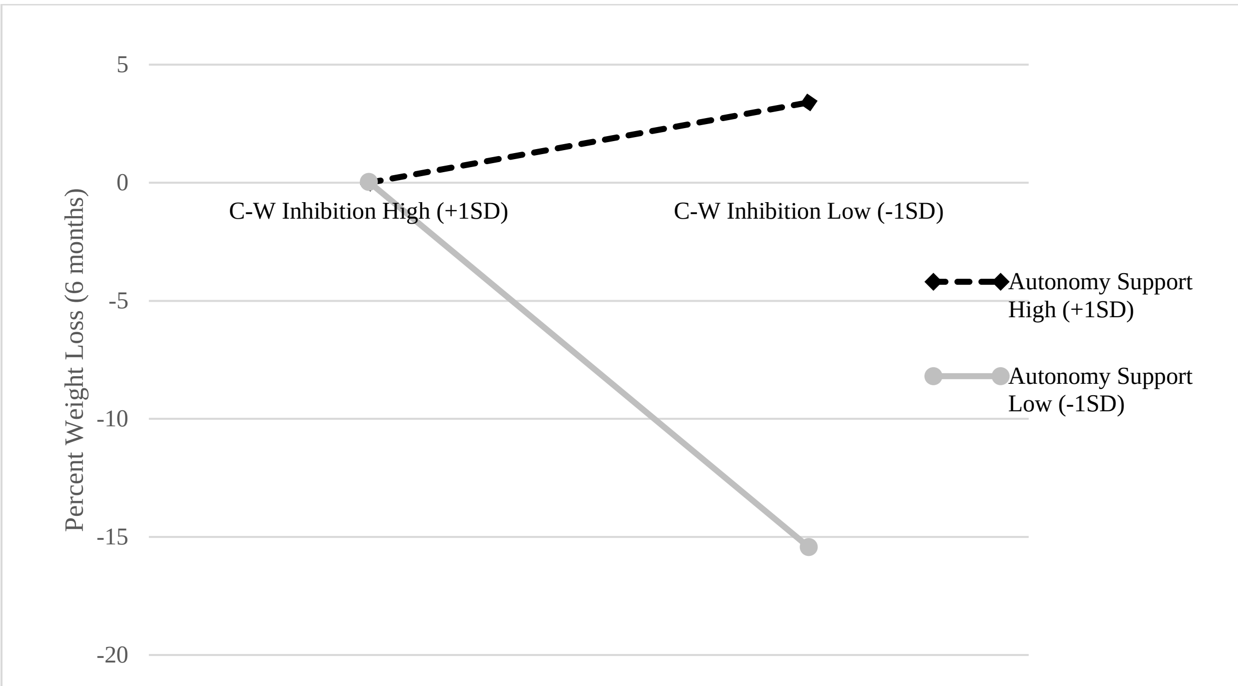


Figure 7

Simple slopes depicting the interaction between BRIEF-A Shifting scores and autonomy support received at 3 months on percent weight loss at 6 months.

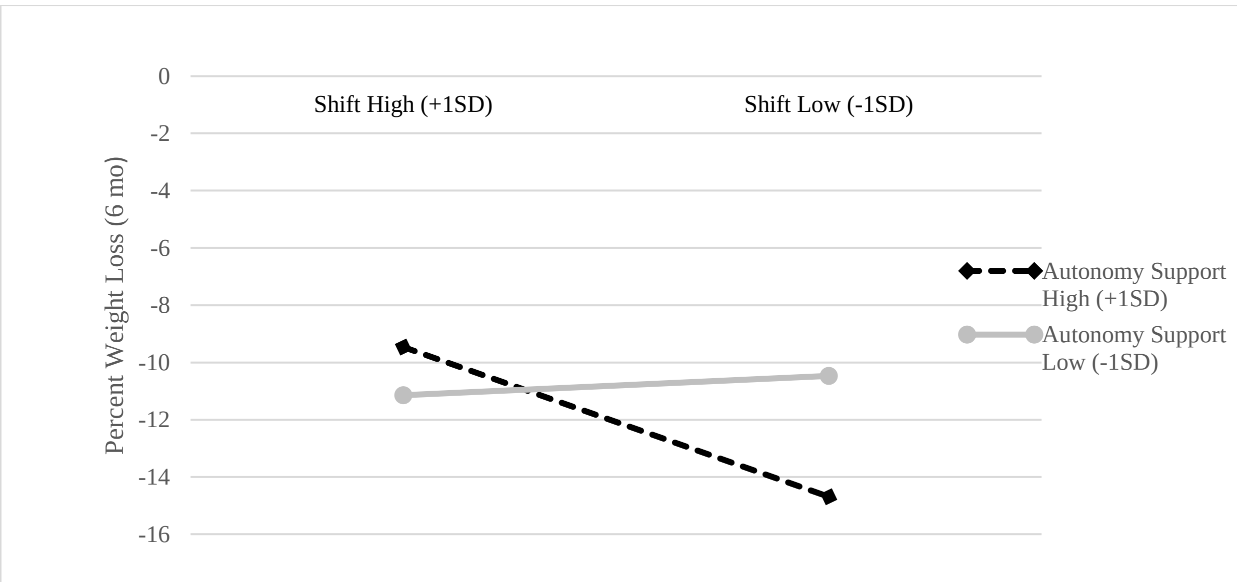


Figure 8

Simple slopes depicting the interaction between BRIEF-A Inhibition scores and autonomy support received at 3 months on percent weight loss at 6 months.

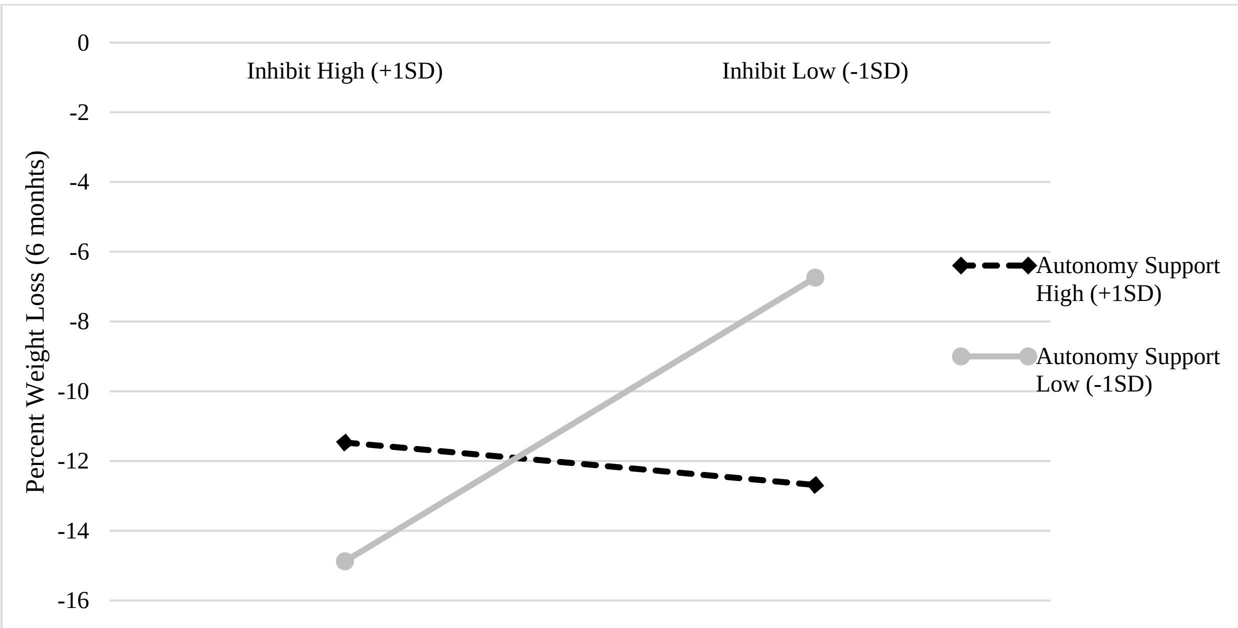


Figure 9

Simple slopes depicting the interaction between BRIEF-A Working Memory scores and autonomy support received at 3 months on percent weight loss at 6 months.

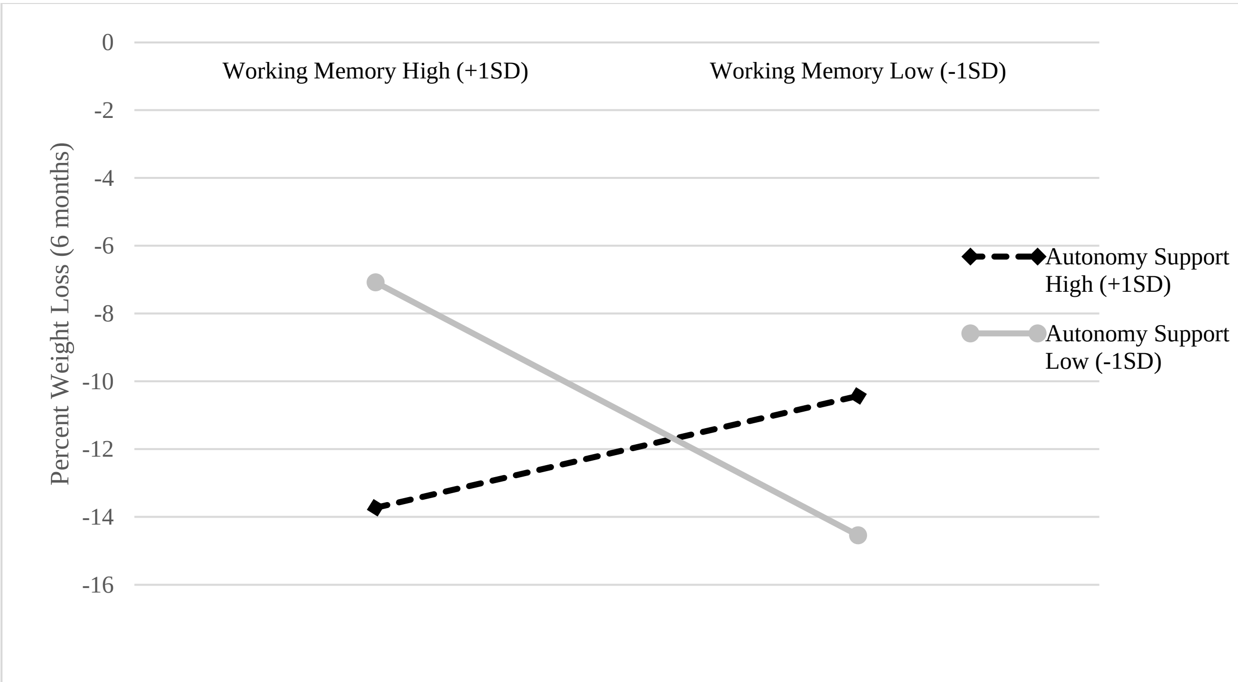


Figure 10

Simple slopes depicting the interaction between Trails A performance and autonomy support received at 6 months on percent weight loss at 12 months.

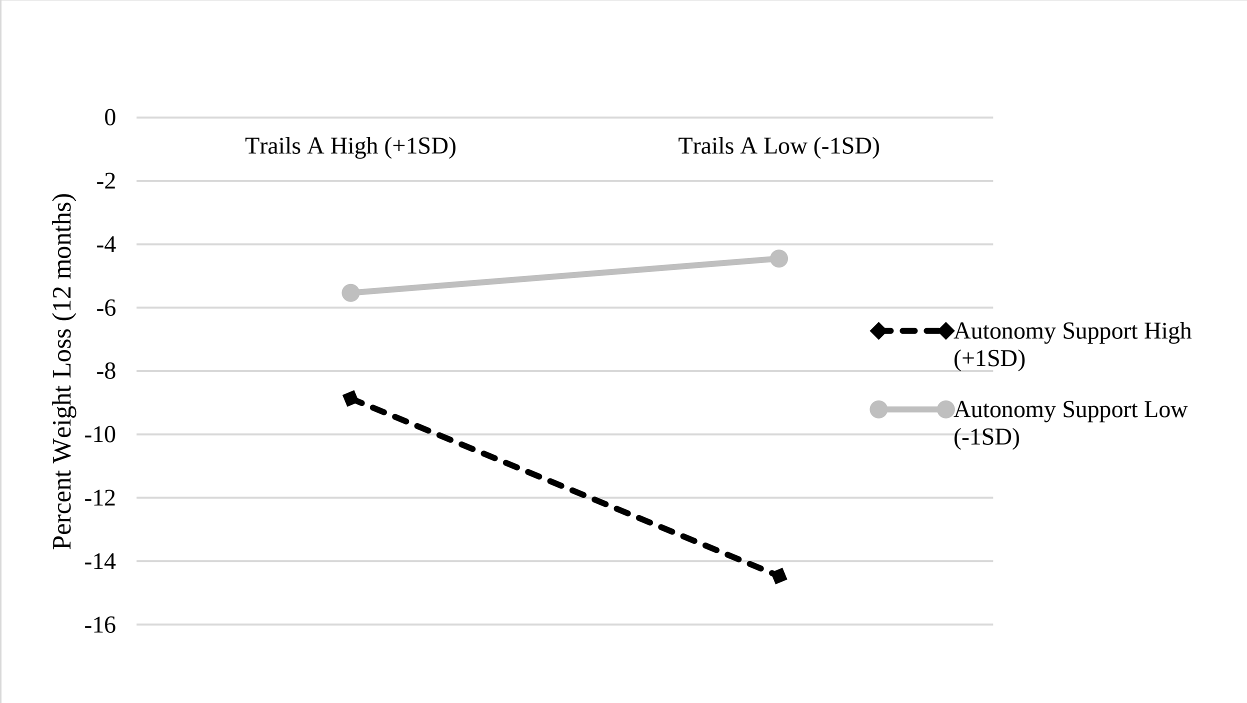


Figure 11

Simple slopes depicting the interaction between Trails A performance and directive support received at 3 months on percent weight loss at 12 months.

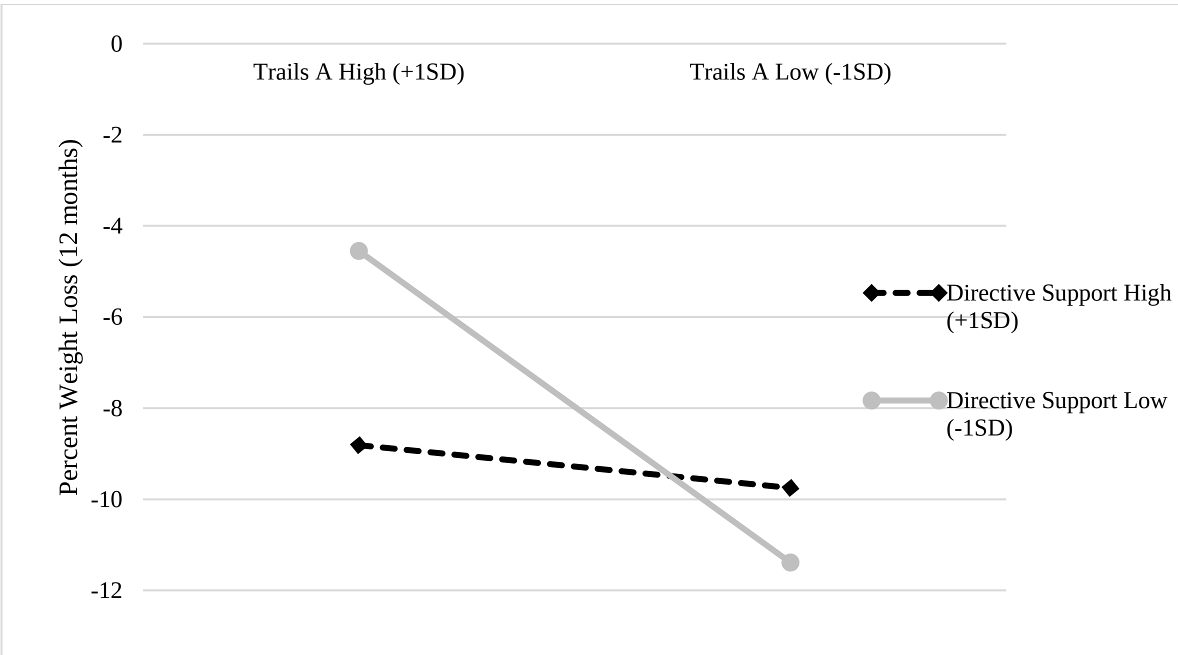


Figure 12

Simple slopes depicting the interaction between BRIEF-A Self-Monitoring scores and directive support received at 6 months on maintenance success (calculated as % change from 6 to 12 months).

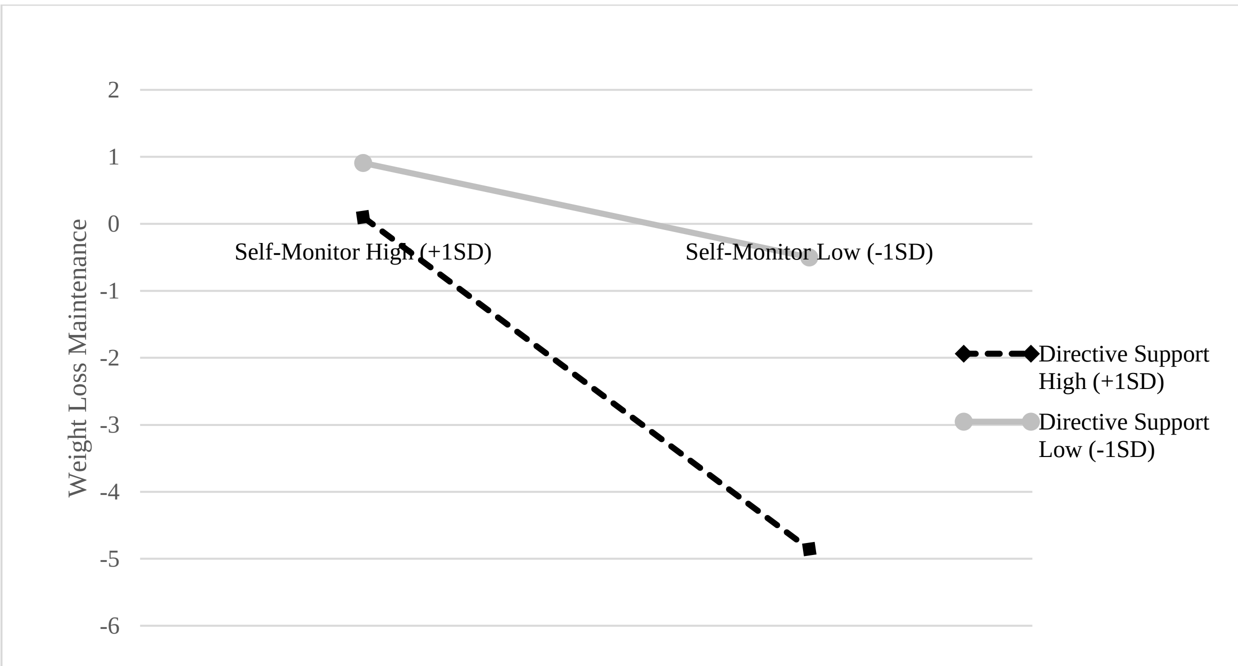


Figure 13

Simple slopes depicting the interaction between D-KEFS Color-Word Inhibition scores and baseline household CHAOS on weight loss at 12 months.

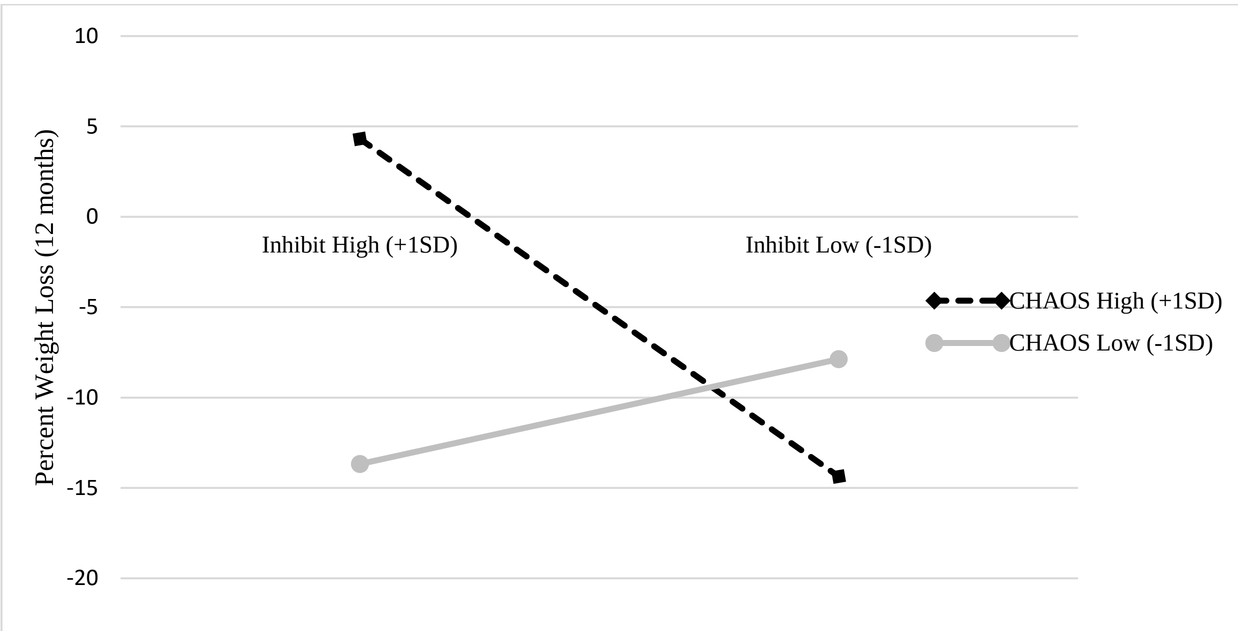


Figure 14

Simple slopes depicting the interaction between BRIEF-A Self-Monitoring scores and baseline household CHAOS on weight loss at 6 months.

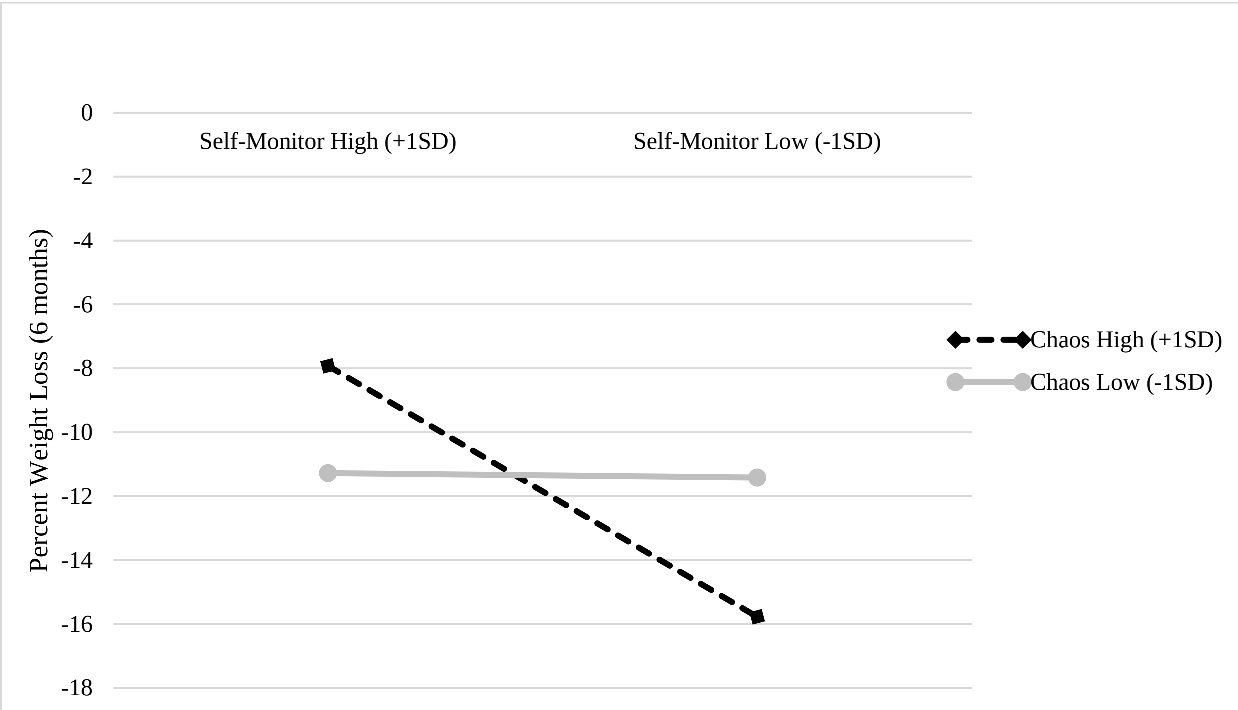
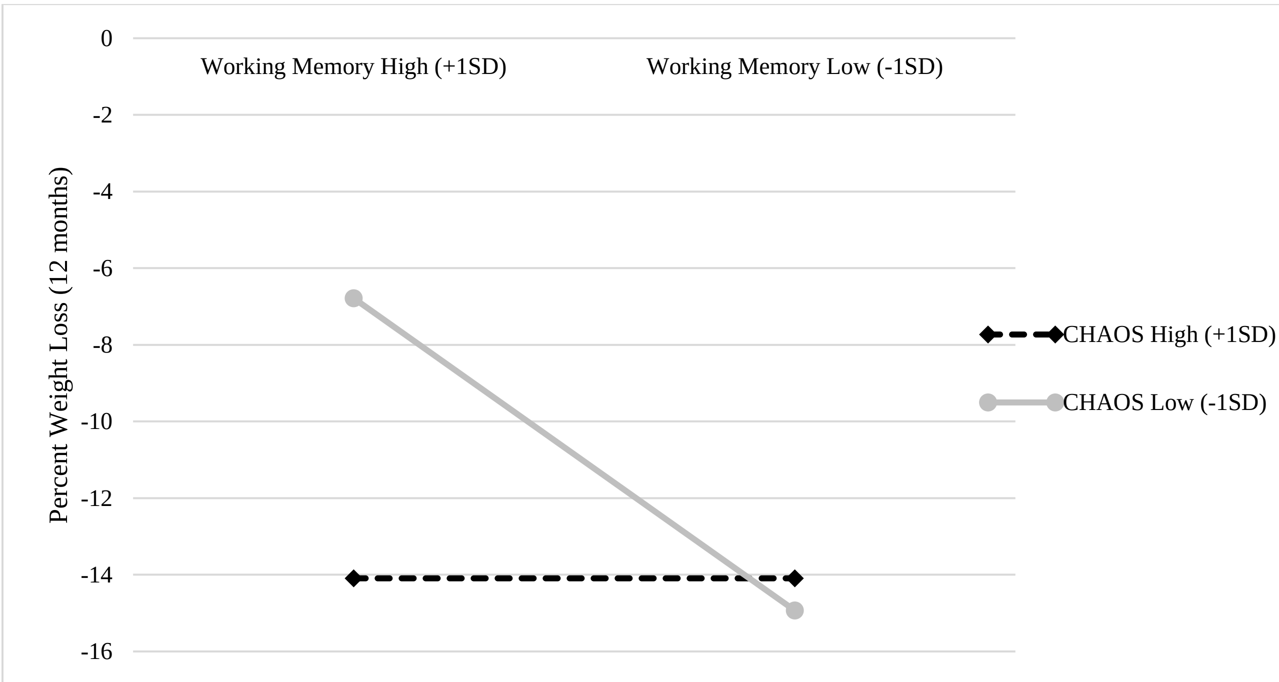


Figure 15

Simple slopes depicting the interaction between BRIEF-A Working-Memory scores and baseline household CHAOS on weight loss at 12 months.



References

Ahern, E., & Semkovska, M. (2017). Cognitive functioning in the first-episode of major depressive disorder: A systematic review and meta-analysis. *Neuropsychology, 31*(1), 52-72. doi:10.1037/neu0000319

Aiken, L.S., & West, S.G. (1991). *Multiple regression: testing and interpreting interactions*. Thousand Oaks, CA: Sage Publications.

Allan, J. L., McMinn, D., & Daly, M. (2016). A Bidirectional Relationship between Executive Function and Health Behavior: Evidence, Implications, and Future Directions. *Frontiers in Neuroscience, 10*, 386.

Allom, V., & Mullan, B. (2014). Individual differences in executive function predict distinct eating behaviours. *Appetite, 80*, 123-130. doi: https://doi.org/10.1016/j.appet.2014.05.007

Allom, V., Mullan, & Hagger. (2016). Does inhibitory control training improve health behaviour? A meta-analysis. *Health Psychol Rev, 10*(2), 168-186. doi:10.1080/17437199.2015.1051078

Allom, V., Mullan, B., Smith, E., Hay, P., & Raman, J. (2018). Breaking bad habits by improving executive function in individuals with obesity. *BMC Public Health, 18*(1), 505. doi:10.1186/s12889-018-5392-y

Alonso-Alonso, M., & Pascual-Leone, A. (2007). The right brain hypothesis for obesity. *JAMA, 297*(16), 1819-1822. doi:10.1001/jama.297.16.1819

Anderson, J. W., Konz, E. C., Frederich, R. C., & Wood, C. L. (2001). Long-term weight-loss maintenance: a meta-analysis of US studies. *The American Journal of Clinical Nutrition, 74*(5), 579-584. doi:10.1093/ajcn/74.5.579

Appelhans, B. M., Fitzpatrick, S. L., Li, H., Cail, V., Waring, M. E., Schneider, K. L., Whited, M.C., Busch, A.M., & Pagoto, S. L. (2014). The home environment and childhood obesity in low-income households: indirect effects via sleep duration and screen time. *BMC public health, 14*, 1160. doi.org/10.1186/1471-2458-14-1160 doi:10.1186/1471-2458-14-1160

Arbuthnott, K., & Frank, J. (2000). Trail Making Test, Part B as a Measure of Executive Control: Validation Using a Set-Switching Paradigm. *Journal of Clinical and Experimental Neuropsychology, 22*(4), 518-528. doi:10.1076/1380-3395(200008)22:4;1-0;FT518

Bates, C. R., Buscemi, J., Nicholson, L. M., Cory, M., Jagpal, A., & Bohnert, A. M. (2018). Links between the organization of the family home environment and child obesity: a systematic review. *Obes Rev, 19*(5), 716-727. doi:10.1111/obr.12662

Benedict, R. H. B., Cox, D., Thompson, L. L., Foley, F., Weinstock-Guttman, B., & Munschauer, F. (2004). Reliable screening for neuropsychological impairment in multiple sclerosis. *Multiple Sclerosis Journal, 10*(6), 675-678. doi:10.1191/1352458504ms1098oa

Berkman, E. T., Falk, E. B., & Lieberman, M. D. (2011). In the trenches of real-world self-sontrol: neural correlates of breaking the link between craving and smoking. *Psychological Science, 22*(4), 498-506. doi:10.1177/0956797611400918

Best, J. R., Nagamatsu, L. S., & Liu-Ambrose, T. (2014). Improvements to executive function during exercise training predict maintenance of physical activity over the following year. *8*(353). doi:10.3389/fnhum.2014.00353

Biessels, G. J., & Reagan, L. P. (2015). Hippocampal insulin resistance and cognitive dysfunction. *Nature Reviews Neuroscience, 16*, 660. doi:10.1038/nrn4019

Black, D. R., Gleser, L. J., & Kooyers, K. J. (1990). A meta-analytic evaluation of couples weight-loss programs. *Health Psychol, 9*(3), 330-347.

Boeka, A. G., & Lokken, K. L. (2008). Neuropsychological performance of a clinical sample of extremely obese individuals. *Archives of Clinical Neuropsychology, 23*(4), 467-474. doi:10.1016/j.acn.2008.03.003

Booker, L., & Mullan, B. (2013). Using the temporal self-regulation theory to examine the influence of environmental cues on maintaining a healthy lifestyle. *British Journal of Health Psychology, 18*(4), 745-762. doi:doi:10.1111/bjhp.12015

Bond, D. S., Jakicic, J. M., Unick, J. L., Vithiananthan, S., Pohl, D., Roye, G. D., Ryder, B.A., Sax, H.C. & Wing, R. R. (2010). Pre- to postoperative physical activity changes in bariatric surgery patients: self report vs. objective measures. *Obesity (Silver Spring), 18*(12), 2395-2397. doi:10.1038/oby.2010.88

Broadley, M. M., White, M. J., & Andrew, B. (2017). A systematic review and meta-analysis of executive function performance in type 1 diabetes mellitus. *Psychosomatic Medicine,* 79(6), 684-696.

Burdick, K. E., Endick, C. J., & Goldberg, J. F. (2005). Assessing cognitive deficits in bipolar disorder: Are self-reports valid? *Psychiatry Research, 136*(1), 43-50. doi:10.1016/j.psychres.2004.12.009

Caldwell, A. E., Masters, K. S., Peters, J. C., Bryan, A. D., Grigsby, J., Hooker, S. A., Wyatt, H.R., & Hill, J. O. (2018). Harnessing centred identity transformation to reduce executive function burden for maintenance of health behaviour change: the maintain IT model. *Health Psychology Review*, 1-23. doi:10.1080/17437199.2018.1437551

Cornelius, T., Gettens, K., Lenz, E., Wojtanowski, A. C., Foster, G. D., & Gorin, A. A. (2018). How prescriptive support affects weight loss in weight-loss intervention participants and their untreated spouses. *Health Psychol, 37*(8), 775-781. doi:10.1037/hea0000630

Cruwys, T., Bevelander, K. E., & Hermans, R. C. J. (2015). Social modeling of eating: A review of when and why social influence affects food intake and choice. *Appetite, 86*, 3-18. doi:https://doi.org/10.1016/j.appet.2014.08.035

Cserjési, R., Luminet, O., Poncelet, A.-S., & Lénárd, L. (2009). Altered executive function in obesity. Exploration of the role of affective states on cognitive abilities. *52*(2), 535-539.

Dassen, F. C. M., Houben, K., Allom, V., & Jansen, A. (2018). Self-regulation and obesity: the role of executive function and delay discounting in the prediction of weight loss. *Journal of Behavioral Medicine*. doi:10.1007/s10865-018-9940-9

Dassen, F. C. M., Houben, K., Van Breukelen, G. J. P., & Jansen, A. (2018). Gamified working memory training in overweight individuals reduces food intake but not body weight. *Appetite, 124*, 89-98. doi:https://doi.org/10.1016/j.appet.2017.05.009

Dohle, S., Diel, K., & Hofmann, W. (2018). Executive functions and the self-regulation of eating behavior: A review. *Appetite, 124*, 4-9. doi:10.1016/j.appet.2017.05.041

Elfhag, K., & Rössner, S. (2005). Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. *Obesity Reviews, 6*(1), 67-85. doi:10.1111/j.1467-789X.2005.00170.x

Elliston, K.G., Ferguson, F.G., & Benjamin, S. (2017). Personal and situational predictors of everyday snacking: An application of temporal self-regulation theory. *British Journal of Health Psychology, 22*(4), 854-871. doi:doi:10.1111/bjhp.12259

Evans, R., Norman, P., & Webb, T. L. (2017). Using Temporal Self-Regulation Theory to understand healthy and unhealthy eating intentions and behaviour. *Appetite, 116*, 357-364. doi:https://doi.org/10.1016/j.appet.2017.05.022

Fernie, G., Peeters, M., Gullo, M. J., Christiansen, P., Cole, J. C., Sumnall, H., & Field, M. (2013). Multiple behavioural impulsivity tasks predict prospective alcohol involvement in adolescents. *Addiction, 108*(11), 1916-1923. doi:10.1111/add.12283

Fiese, B. H., Rhodes, H. G., & Beardslee, W. R. (2013). Rapid Changes in American Family Life: Consequences for Child Health and Pediatric Practice. *Pediatrics, 132*(3), 552-559. doi:10.1542/peds.2013-0349

Fitzpatrick, S., Gilbert, S., & Serpell, L. (2013). Systematic Review: Are Overweight and Obese Individuals Impaired on Behavioural Tasks of Executive Functioning? *Neuropsychology Review, 23*(2), 138-156. doi:10.1007/s11065-013-9224-7

Forman, E. M., Goldstein, S. P., Flack, D., Evans, B. C., Manasse, S. M., & Dochat, C. (2018). Promising technological innovations in cognitive training to treat eating-related behavior. *Appetite, 124*, 68-77. doi:https://doi.org/10.1016/j.appet.2017.04.011

Gabriele, J. M., Carpenter, B. D., Tate, D. F., & Fisher, E. B. (2011). Directive and Nondirective E-Coach Support for Weight Loss in Overweight Adults. *Annals of Behavioral Medicine, 41*(2), 252-263. doi:10.1007/s12160-010-9240-2

Galioto, R., Britton, K., Bond, D. S., Gunstad, J., Pera, V., Rathier, L., & Tremont, G. (2018). Executive functions are associated with weight loss during participation in a medically supervised weight loss program. *Obesity Medicine, 9*, 18-20. doi:https://doi.org/10.1016/j.obmed.2017.12.002

Garcia, S., Fedor, A., Spitznagel, M. B., Strain, G., Devlin, M. J., Cohen, R. A., . . . Gunstad, J. (2013). Patient reports of cognitive problems are not associated with neuropsychological test performance in bariatric surgery candidates. *Surgery for Obesity and Related Diseases, 9*(5), 797-801. doi:10.1016/j.soard.2012.10.008

Gettens, K.M., Carbonneau, N., Koestner, R., Powers, T.A., & Gorin, A.A. (2018). The role of partner autonomy support in motivation, well-being and weight loss among women with higher baseline BMI. *Families, Systems, & Health, 36(3),* 347-356. doi:10.1037/fsh0000362.

Gettens, K. M., & Gorin, A. A. (2017). Executive function in weight loss and weight loss maintenance: a conceptual review and novel neuropsychological model of weight control. *Journal of Behavioral Medicine, 40*(5), 687-701. doi:10.1007/s10865-017-9831-5

Gokee-LaRose, J., Gorin, A. A., & Wing, R. R. (2009). Behavioral self-regulation for weight loss in young adults: a randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity, 6*(1), 10. doi:10.1186/1479-5868-6-10

Gonzales, M. M., Tarumi, T., Miles, S. C., Tanaka, H., Shah, F., & Haley, A. P. (2010). Insulin sensitivity as a mediator of the relationship between BMI and working memory-related brain activation. *Obesity, 18*(11), 2131-2137. doi:10.1038/oby.2010.183

Gorin, A.A., Lenz, E.M., Cornelius, T., Huedo-Medina, T., Wojtanowski Alexis, C., & Foster Gary, D. (2018). Randomized controlled trial examining the ripple effect of a nationally available weight management program on untreated spouses. *Obesity, 26*(3), 499-504. doi:10.1002/oby.22098

Gorin, A.A,. Powers, T., Gettens, K., Cornelius, T., Koestner, T., Mobley, A., Pescatello, L., & Medina, T.H. (2017). Project TEAMS (Talking about Eating, Activity, and Mutual

Support): a randomized controlled trial of a theory-based weight loss program for couples. *BMC Public Health, 17*(1), 749. doi:10.1186/s12889-017-4732-7
Gorin, A.A., Powers, T., Koestner, T., Wing, R.R. & Raynor, H. (2014). Autonomy support, self-regulation, and weight loss. *Health Psychology, 33*(4), 332-339. doi:10.1037/a0032586
Gorin, A.A., Raynor, H., Fava, J., Maguire, K., Robichaud, E., Trautvetter, J., Crane, M. & Wing, R.R. (2013). Randomized controlled trial of a comprehensive home environment-focused weight loss program for adults. *Health Psychology, 32*(2), 128-137. doi:10.1037/a0026959
Gorin, A.A., Wing, R.R., Fava, J.L., Jakicic, J.M., Jeffery, R., West, D.S., Brelje, K., DiLillo, V.G., & Look AHEAD Home Environment Research Group. (2008). Weight loss treatment influences untreated spouses and the home environment: Evidence of a ripple effect. *International journal of obesity, 32*(11), 1678-1684. doi:10.1038/ijo.2008.150
Green, M. W., Elliman, N. A., & Kretsch, M. J. (2005). Weight loss strategies, stress, and cognitive function: supervised versus unsupervised dieting. *Psychoneuroendocrinology, 30*(9), 908-918. doi:10.1016/j.psyneuen.2005.05.005
Gutierrez-Colina, A. M., Eaton, C. K., Lee, J. L., Reed-Knight, B., Loiselle, K., Mee, L. L., LaMotte, J., Liverman, R., & Blount, R. L. (2016). Executive functioning, barriers to adherence, and nonadherence in adolescent and young adult transplant recipients. *J Pediatr Psychol, 41*(7), 759-767. doi:10.1093/jpepsy/jsv107
Hall, & Fong. (2007). Temporal self-regulation theory: A model for individual health behavior. *Health Psychology Review, 1*(1), 6-52. doi:10.1080/17437190701492437
Hall, P. A., & Fong, G. T. (2015). Temporal self-regulation theory: a neurobiologically informed model for physical activity behavior. *Frontiers in Human Neuroscience, 9*(117). doi:10.3389/fnhum.2015.00117
Hall, & Marteau. (2014). Executive function in the context of chronic disease prevention: theory, research and practice. *Prev Med, 68*, 44-50. doi:10.1016/j.ypmed.2014.07.008
Hall, P. A., Fong, G. T., Epp, L. J., & Elias, L. J. (2008). Executive function moderates the intention-behavior link for physical activity and dietary behavior. *Psychology & Health, 23*(3), 309-326. doi:10.1080/14768320701212099
Hall, P. A., & Marteau, T. M. (2014). Executive function in the context of chronic disease prevention: theory, research and practice. *Prev Med, 68*, 44-50. doi:10.1016/j.ypmed.2014.07.008
Hayes, J., Eichen, D., Barch, D., & Wilfley, D. (2018). Executive function in childhood obesity: Promising intervention strategies to optimize treatment outcomes. *Appetite, 124*, 10-23. doi:10.1016/j.appet.2017.05.040
Heaton, R. K., Avitable, N., Grant, I., & Matthews, C. G. (1999). Further crossvalidation of regression-based neuropsychological norms with an update for the Boston Naming Test. *J Clin Exp Neuropsychol, 21*(4), 572-582. doi:10.1076/jcen.21.4.572.882
Herman, C. P. (2015). The social facilitation of eating. A review. *Appetite, 86*, 61-73. doi:https://doi.org/10.1016/j.appet.2014.09.016
Hill, J. O., & Peters, J. C. (1998). Environmental contributions to the obesity epidemic. *Science, 280*(5368), 1371-1374. doi:10.1126/science.280.5368.1371

Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences, 16*(3), 174-180. doi:https://doi.org/10.1016/j.tics.2012.01.006

Insel, K., Morrow, D., Brewer, B., & Figueredo, A. (2006). Executive function, working memory, and medication adherence among older adults. *The Journals of Gerontology: Series B, 61*(2), P102-P107. doi:10.1093/geronb/61.2.P102

Jansen, A., Houben, K., & Roefs, A. (2015). A cognitive profile of obesity and its translation into new interventions. *Frontiers in Psychology, 6*(1807). doi:10.3389/fpsyg.2015.01807

Jansen, A., Vanreyten, A., van Balveren, T., Roefs, A., Nederkoorn, C., & Havermans, R. (2008). Negative affect and cue-induced overeating in non-eating disordered obesity. *Appetite, 51*(3), 556-562. doi:https://doi.org/10.1016/j.appet.2008.04.009

Jones, Hardman, Lawrence, & Field. (2018). Cognitive training as a potential treatment for overweight and obesity: A critical review of the evidence. *Appetite, 124,* 50-67. doi:10.1016/j.appet.2017.05.032

Jones, A., Hardman, C. A., Lawrence, N., & Field, M. (2018). Cognitive training as a potential treatment for overweight and obesity: A critical review of the evidence. *Appetite, 124,* 50-67. doi:https://doi.org/10.1016/j.appet.2017.05.032

Kishinevsky, F. I., Cox, J. E., Murdaugh, D. L., Stoeckel, L. E., Cook, E. W., & Weller, R. E. (2012). fMRI reactivity on a delay discounting task predicts weight gain in obese women. *Appetite, 58*(2), 582-592. doi:https://doi.org/10.1016/j.appet.2011.11.029

Kober, H., Mende-Siedlecki, P., Kross, E. F., Weber, J., Mischel, W., Hart, C. L., & Ochsner, K. N. (2010). Prefrontal–striatal pathway underlies cognitive regulation of craving. *107*(33), 14811-14816. doi:10.1073/pnas.1007779107 %J Proceedings of the National Academy of Sciences

Koestner, & Losier. (2002). Distinguishing three ways of being internally motivated: a closer look at introjection, identification, and intrinsic motivation. Edited by Deci EL, Ryan RM, Rochester, NY: University of Rochester Press.

Koestner, R., Otis, N., Powers, T. A., Pelletier, L., & Gagnon, H. (2008). Autonomous motivation, controlled motivation, and goal progress. *J Pers, 76*(5), 1201-1230. doi:10.1111/j.1467-6494.2008.00519.x

Koestner, Powers, Carbonneau, Milyavskaya, & Chua. (2012). Distinguishing Autonomous and Directive Forms of Goal Support:Their Effects on Goal Progress, Relationship Quality, and Subjective Well-Being. *Personality and Social Psychology Bulletin, 38*(12), 1609-1620. doi:10.1177/0146167212457075

Koestner, R., Powers, T. A., Carbonneau, N., Milyavskaya, M., & Chua, S. N. (2012). Distinguishing autonomous and directive forms of goal support: their effects on goal progress, relationship quality, and subjective well-being. *Personality and Social Psychology Bulletin, 38*(12), 1609-1620. doi:10.1177/0146167212457075

Lally, P., Wardle, J., & Gardner, B. (2011). Experiences of habit formation: a qualitative study. *Psychol Health Med, 16*(4), 484-489. doi:10.1080/13548506.2011.555774

Leroux, J. S., Moore, S., & Dube, L. (2013). Beyond the "I" in the obesity epidemic: a review of social relational and network interventions on obesity. *J Obes, 2013,* 348249. doi:10.1155/2013/348249

Loprinzi, P. D., Herod, S. M., Walker, J. F., Cardinal, B. J., Mahoney, S. E., & Kane, C. (2015). Development of a conceptual model for smoking cessation: physical activity,

neurocognition, and executive functioning. *Res Q Exerc Sport, 86*(4), 338-346. doi:10.1080/02701367.2015.1074152
Lowe, Butryn, & Zhang. (2018). Evaluation of meal replacements and a home food environment intervention for long-term weight loss: a randomized controlled trial. *The American Journal of Clinical Nutrition, 107*(1), 12-19. doi:10.1093/ajcn/nqx005
Lowe M.R., Tappe, K.A., Annunziato, R. A., Riddell, L.J., Coletta, M.C., Crerand, C. E., Didie, E.R., Ochner, C.N., McKinney, S. (2012). The effect of training in reduced energy density eating and food self-monitoring accuracy on weight loss maintenance. *Obesity, 16*(9), 2016-2023. doi:10.1038/oby.2008.270
Lowe, M. R., Butryn, M. L., & Zhang, F. (2018). Evaluation of meal replacements and a home food environment intervention for long-term weight loss: a randomized controlled trial. *The American Journal of Clinical Nutrition, 107*(1), 12-19. doi:10.1093/ajcn/nqx005
Ludyga, S., Gerber, M., Brand, S., Hosboer-Trachsler, E., & Puhse, U. (2016). Acute effects of moderate aerobic exercise on specific aspects of executive function in different age and fitness groups: A meta-analysis. *Psychosom Med, 79*(6), 684-696. doi:10.1097/psy.000000000000046010.1111/psyp.12736
Lupien, S. J., Gillin, C. J., & Hauger, R. L. (1999). Working memory is more sensitive than declarative memory to the acute effects of corticosteroids: a dose-response study in humans. *Behav Neurosci, 113*(3), 420-430.
MacRae, L. M., Darlington, G., Haines, J., & Ma, D. W. L. (2017). Examination of associations between chaos in the home environment, serum cortisol level, and dietary fat intake among parents of preschool-age children. *Applied Physiology, Nutrition, and Metabolism, 42*(7), 788-791. doi:10.1139/apnm-2016-0659
Maes, S., & Karoly, P. (2005). Self-regulation assessment and intervention in physical health and illness: a review. *Applied Psychology, 54*(2), 267-299. doi:10.1111/j.1464-0597.2005.00210.x
Matheny, A. P., Wachs, T. D., Ludwig, J. L., & Phillips, K. (1995). Bringing order out of chaos: psychometric characteristics of the confusion, hubbub, and order scale. *Journal of Applied Developmental Psychology, 16*(3), 429-444. doi:https://doi.org/10.1016/0193-3973(95)90028-4
McClelland, J., Dalton, B., Kekic, M., Bartholdy, S., Campbell, I. C., & Schmidt, U. (2016). A systematic review of temporal discounting in eating disorders and obesity: Behavioural and neuroimaging findings. *Neuroscience & Biobehavioral Reviews, 71*, 506-528. doi:https://doi.org/10.1016/j.neubiorev.2016.09.024
Metzgar, C. J., Preston, A. G., Miller, D. L., & Nickols-Richardson, S. M. (2015). Facilitators and barriers to weight loss and weight loss maintenance: a qualitative exploration. *J Hum Nutr Diet, 28*(6), 593-603. doi:10.1111/jhn.12273
Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., . . . Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences of the United States of America, 108*(7), 2693-2698.
Olson, K., Bond, D., & Wing, R. R. (2017). Behavioral approaches to the treatment of obesity. *R I Med J (2013), 100*(2), 21-24.
Papas, M. A., Alberg, A. J., Ewing, R., Helzlsouer, K. J., Gary, T. L., & Klassen, A. C. (2007). The built environment and obesity. *Epidemiologic Reviews, 29*(1), 129-143. doi:10.1093/epirev/mxm009

Peeters, M., Janssen, T., Monshouwer, K., Boendermaker, W., Pronk, T., Wiers, R., & Vollebergh, W. (2015). Weaknesses in executive functioning predict the initiating of adolescents' alcohol use. *Dev Cogn Neurosci, 16*, 139-146. doi:10.1016/j.dcn.2015.04.003

Powers, T. A., Koestner, R., & Gorin, A. A. (2008). Autonomy support from family and friends and weight loss in college women. *Families, Systems, & Health, 26*(4), 404-416. doi:10.1037/1091-7527.26.4.404

Roca, M., Vives, M., Lopez-Navarro, E., Garcia-Campayo, J., & Gili, M. (2015). Cognitive impairments and depression: a critical review. *Actas Esp Psiquiatr, 43*(5), 187-193.

Rock, P. L., Roiser, J. P., Riedel, W. J., & Blackwell, A. D. (2014). Cognitive impairment in depression: a systematic review and meta-analysis. *Psychol Med, 44*(10), 2029-2040. doi:10.1017/s0033291713002535

Roth, R. M., Lance, C. E., Isquith, P. K., Fischer, A. S., & Giancola, P. R. (2013). Confirmatory factor analysis of the behavior rating inventory of executive function-adult version in healthy adults and application to attention-deficit/hyperactivity disorder. *Archives of Clinical Neuropsychology, 28*(5), 425-434. doi:10.1093/arclin/act031

Rouel, M., Raman, J., Hay, P., & Smith, E. (2016). Validation of the behaviour rating inventory of executive function – adult version (BRIEF-A) in the obese with and without binge eating disorder. *Eating Behaviors, 23*, 58-65. doi:https://doi.org/10.1016/j.eatbeh.2016.07.010

Ryan, R. M., & Deci, E. L. (2002). *Overview of self-determination theory: An organismic dialectical perspective*. Edited by Deci E.L., Ryan R.M., Rochester, NY: Rochester University Press.

Schierberl Scherr, A. E., McClure Brenchley, K. J., & Gorin, A. A. (2013). Examining a ripple effect: do spouses' behavior changes predict each other's weight loss? *Journal of Obesity, 2013*, 297268. doi:10.1155/2013/297268

Sheeran, & Webb. (2016). The Intention–Behavior Gap. *Social and Personality Psychology Compass, 10*(9), 503-518. doi:doi:10.1111/spc3.12265

Siervo, M., Arnold, R., Wells, J.C.K., Tagliabue, A., Colantuoni, A., Albanese, E., Brayne, e., & Stephan, B.C.M. (2011). Intentional weight loss in overweight and obese individuals and cognitive function: a systematic review and meta-analysis. *Obesity Reviews, 12*(11), 968-983. doi:doi:10.1111/j.1467-789X.2011.00903.x

Smith, Hay, Campbell, & Trollor. (2011). A review of the association between obesity and cognitive function across the lifespan: implications for novel approaches to prevention and treatment. *Obesity Reviews, 12*(9), 740-755. doi:doi:10.1111/j.1467-789X.2011.00920.x

Spitznagel, M. B., Alosco, M., Strain, G., Devlin, M., Cohen, R., Paul, R., . . . Gunstad, J. (2013). Cognitive function predicts 24-month weight loss success after bariatric surgery. *Surg Obes Relat Dis, 9*(5), 765-770. doi:10.1016/j.soard.2013.04.011

Spitznagel, M. B., Hawkins, M., Alosco, M., Galioto, R., Garcia, S., Miller, L., & Gunstad, J. (2015). Neurocognitive Effects of Obesity and Bariatric Surgery. *Eur Eat Disord Rev, 23*(6), 488-495. doi:10.1002/erv.2393

Stewart, D. W., Gabriele, J. M., & Fisher, E. B. (2012). Directive support, nondirective support, and health behaviors in a community sample. *Journal of Behavioral Medicine, 35*(5), 492-499. doi:10.1007/s10865-011-9377-x

Stojek, M. M. K., & MacKillop, J. (2017). Relative reinforcing value of food and delayed reward discounting in obesity and disordered eating: A systematic review. *Clinical Psychology Review, 55*, 1-11. doi:https://doi.org/10.1016/j.cpr.2017.04.007

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *The International Journal of Behavioral Nutrition and Physical Activity, 9*, 78-78. doi:10.1186/1479-5868-9-78

Teixeira, P. J., Carraça, E. V., Marques, M. M., Rutter, H., Oppert, J.M., De Bourdeaudhuij, I., Lakerveld, J., & Brug, J. (2015). Successful behavior change in obesity interventions in adults: a systematic review of self-regulation mediators. *BMC Medicine, 13*, 84. doi:10.1186/s12916-015-0323-6

Vartanian, Herman, & Wansink. (2008). Are we aware of the external factors that influence our food intake? *Health Psychol, 27*(5), 533-538. doi:10.1037/0278-6133.27.5.533

Vartanian, Spanos, Herman, & Polivy. (2015). Modeling of food intake: a meta-analytic review. *Social Influence, 10*(3), 119-136. doi:10.1080/15534510.2015.1008037

Vartanian, L. R., Herman, C. P., & Wansink, B. (2008). Are we aware of the external factors that influence our food intake? *Health Psychol, 27*(5), 533-538. doi:10.1037/0278-6133.27.5.533

Vartanian, L. R., Kernan, K. M., & Wansink, B. (2016). Clutter, chaos, and overconsumption: the role of mind-set in stressful and chaotic food environments. *Environment and Behavior, 49*(2), 215-223. doi:10.1177/0013916516628178

Vartanian, L. R., Spanos, S., Herman, C. P., & Polivy, J. (2015). Modeling of food intake: a meta-analytic review. *Social Influence, 10*(3), 119-136. doi:10.1080/15534510.2015.1008037

Verbeken, S., Braet, C., Goossens, L., & van der Oord, S. (2013). Executive function training with game elements for obese children: a novel treatment to enhance self-regulatory abilities for weight-control. *Behaviour research and therapy, 51*(6), 290-299. doi:10.1016/j.brat.2013.02.006

Veronese, N., Facchini, S., Stubbs, B., Luchini, C., Solmi, M., Manzato, E., Sergi, G., Maggi, S., Cosco, T., & Fontana, L. (2017). Weight loss is associated with improvements in cognitive function among overweight and obese people: A systematic review and meta-analysis. *Neurosci Biobehav Rev, 72*, 87-94. doi:10.1016/j.neubiorev.2016.11.017

Weller, R. E., Cook, E. W., Avsar, K. B., & Cox, J. E. (2008). Obese women show greater delay discounting than healthy-weight women. *Appetite, 51*(3), 563-569. doi:https://doi.org/10.1016/j.appet.2008.04.010

Whitelock, V., Nouwen, A., van den Akker, O., & Higgs, S. (2018). The role of working memory sub-components in food choice and dieting success. *Appetite, 124*, 24-32. doi:https://doi.org/10.1016/j.appet.2017.05.043

Williams, McGregor, Zeldman, Freedman, Deci, & Deci. (2004). Testing a self-determination theory process model for promoting glycemic control through diabetes self-management. (0278-6133 (Print)).

Wing, R. R., & Phelan, S. (2005). Long-term weight loss maintenance. *The American journal of clinical nutrition, 82*(1 Suppl), 222S-225S. doi:10.1093/ajcn/82.1.222s

Yang, Y., Shields, G. S., Guo, C., & Liu, Y. (2018). Executive function performance in obesity and overweight individuals: A meta-analysis and review. *Neuroscience & Biobehavioral Reviews, 84*, 225-244. doi:https://doi.org/10.1016/j.neubiorev.2017.11.020

Zoltak, M. J., Veling, H., Chen, Z., & Holland, R. W. (2018). Attention! Can choices for low value food over high value food be trained? *Appetite, 124*, 124-132. doi:https://doi.org/10.1016/j.appet.2017.06.010