# The Effect of a Salient Environmental Cue on Weight Loss

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## Abstract

*Obesity continues to be an alarming health concern. Numerous variables, including environmental factors, have been associated with increases in obesity. Curiously, there is little research on how the environment may be employed to reduce excess body weight. Here we examine the role of a specific environmental manipulation that may assist in reducing caloric intake. Participants in a weight loss program were randomly placed into either a control or experimental group. Each group received identical weight loss counseling and informational handouts. For the manipulation, removable stickers (5cm x 10cm) were given to each experimental group member with instructions to place them in the most obvious, salient locations. Total body weight was recorded each week of the study. Results reveal significantly more weight loss for the experimental group compared to the control group. We conclude that salient environmental cues may be a useful aide in efforts to reduce body weight.*

***Keywords***: obesity, environmental cues, weight loss,

## *Introduction*

Research on obesity and weight management is extensive. The majority of studies have dealt with the physiological, sociological or psychological mechanisms involved in the regulation of appetite and food consumption (Feng, Glass, Curriero, Stewart, & Schwartz, 2010; Janssen, Katzmarzyk, Boyce, Vereecken, Mulvihill, Roberts, Currie & Pickett, 2005; Monasta, Batty, Cattaneo, Lutje, Ronfani, Van Lenthe, & Brug, 2010; Ogden, Carroll, Kit, & Flegal, 2014; Ogden, Carroll, Kit, & Flegal, 2012; Padwal, Li, & Lau, 2003; Reilly and Kelly, 2011; Rosenheck, 2008; Serdula, Ivery, Coates, Freedman, Williamson, & Byers, 1993; Sobal and Stunkard, 1989; Wang and Beydoun, 2007). Recently, researchers have begun focusing on the impact of environmental factors that may play in a role in eating behaviors (Ogden, Dalkou, Kousantoni, Ventura, & Reynolds, 2016; Shimizu, Payne & Wansink 2010). This research has been heavily focused on examining variables that promote eating and excess calorie intake (Wansink & Sorbal, 2007). The existing research demonstrates that we are unaware of many of the food decisions we make each day due to subtle influences in our environment. For example, it has been shown that participants will eat more calories/food when it is offered in a larger bowl. Of even more interest is the fact that 21% of those research participants who over-consumed denied they ate more, while 75% cited reasons other than size of the bowl for the over consumption. Out of all the participants, only 4% correctly cited the larger bowl as the factor influencing overconsumption (Wansink & Sorbal, 2007).

Environmental influences on food consumption are not limited to the actual food or food preparation. A study by Winkielman, Berridge, and Wilbarger (2005) showed that observing an angry face decreased the consumption and valuation of a beverage while viewing a happy face increased the amount individuals are willing to consume as well as how much they are willing to pay for the beverage. The researchers presented a subliminal image of a smiling face, in which participants did not report any affective changes nor did they report seeing the face. This subliminal image still led to higher valuation and increased consumption (Winkielman et al., 2005). It has been found that variables in our environment may even be powerful enough to influence the perceived taste of food. Wansink, Ittersum, and Painter (2004) found that diet and health labels improved the taste of less healthy, hedonic foods. However, positive labeling did not influence the taste of healthier alternative foods (Wansink et al., 2004).

The ability of factors in the environment to regulate our eating behaviors has led to the elucidation of some subtle influences on food intake. For example, it has been demonstrated that the number of people you dine with can affect your food intake. In an early study on group eating, dining in large groups led research participants to consume 75% larger meals compared to when the participants ate alone (Castro & Brewer, 1992). A later study found that the amount consumed by participants in large groups increased as the length of the meal (time) was increased (Bell & Pliner, 2003). A positive correlation between group size and food consumption as well as meal duration and food consumption has been found through these studies. Even the time of the year contributes to weight gain. For example, the weight of research participants increased significantly during holiday seasons (Yanovski, Yanovski, Sovik, Nguyen, O'Neil & Sebring, 2000).

Perception is another factor potentially leading to overconsumption. One study found that labeling a presentation of food as either a meal or a snack affected how much an individual consumed during that opportunity, as well as how much they consumed the rest of the day (Wansink, Payne, Shimizu, 2010). The perceived availability of food can also lead to overconsumption following the simple rule that the more food available, the more we consume. This was demonstrated in an experiment that provided increasing amounts of food that were systematically provided to undergraduate college students in a buffet-style eating situation. Researchers observed that the food intake increased with the increases in availability (Levitsky & Youn, 2004). Perceived convenience and visibility also has a pronounced affect on consumption. In a study that has been replicated countless times in homes and office settings, having a clear jar of candy leads to much faster consumption of what is inside the jar as compared to an opaque jar full of identical food (Painter, Wansink & Hieggelke, 2002).

The perception of how much food is remaining on one's plate can also influence consumption. Through the use of self-filling bowls, researchers found that participants consumed 73% more soup while believing they only consumed the amount the bowl would normally hold. Interestingly enough, they did not report feeling any more fulfilled from the consumption than their peers who only consumed a single bowl serving (Wansink & Chandon, 2006). It has been shown that even the type of utensils we use can contribute to how much is consumed, which apparently occurs without conscious awareness of the factors influencing our eating behaviors (Sobal & Wansink, 2007). Specifically, larger utensils lead to larger consumption. Another clever study demonstrated that perceived food variety led to increased food consumption. Through a simple manipulation of presenting the same food in a different manner participants consumed more calories compared to when a single food was presented in the same manner. Even though there was no variety in the food being consumed, people ate more compared to when it was obvious that the food choices were limited to one option. It was also found that the structure of the assortment moderates the effect of actual variety on perceived variety (Kahn & Wansink, 2004). In other words, changing a sensory modality (such as color) of the food was enough for the food to be perceived as varied. There have been findings with pre-school children showing that visual cues affect their ability to abnegate with regards to food choices (Forzano, Szuba & Figurilli, 2003). More recent studies show a clear pattern of excess food intake when children are primed with images of attractive foods (Papeis & Hamstra, 2010). This effect occurs even when the children are unaware of the cue, such as food images embedded in video games (Folkvord, Anschutz, Nederkoorn, Westerik, and Buijzen, 2014). This is alarming given that the depictions of unhealthy food and eating habits are presented twice as frequently on children compared to adult television programming (Radnitz, Byrne, Goldman, Sparks, Gantshar, & Tung, 2009). Additionally, television cues involving food have been shown to prime individuals to increase thoughts about food as well as enhance the desire to consume certain foods (Kemps, Tiggerman, & Hollitt, 2014). It has been concluded that the current obesity epidemic has occurred, in part, due to an increase in the saliency and abundance of food affecting all demographics and socioeconomic levels (Cohen, 2008).

This difference of perceptions seems to have a biological basis. Studies have shown that dietary changes can result in different parts of the brain increasing in neural activity during consumption of certain foods labeled "forbidden" by the dieters. When a subject deprived themselves of a particular food, they experienced strong food cravings in an area of the brain purported to be associated with eating and other motivated behaviors (Polivy, Coleman & Peter, 2005). Research exploring a role for environmental factors to help *reduce* caloric intake has been limited. One such study found that exposure to food cues strengthened diet related goals for those who were found to have low dietary restraints, but these cues had no measurable effect on individuals with medium or high levels of dieting restraint (Coelho, Polivy, Herman, & Pliner, 2008). Furthermore, it has been demonstrated that participants under a high cognitive load consumed significantly less food in situations in which diets were made salient (Mann & Ward, 2004).

Thus, researchers do recognize the impact of various environmental factors and suggest they may be influencing dispositional traits, such as impulse eating and sensitivity to reward. This makes certain individuals extremely vulnerable to excessive food consumption (Hetherington, 2007), prompting the authors of that research to propose that personalized nutritional behavior strategies be employed to help individuals become less vulnerable to such environmental factors (Hetherington, 2007). Other studies suggest that an informational approach may have an effect of reducing the consumption of high calorie/low nutritional foods (Tandon, Wright, Chaun, Rogers, & Christakis, 2010). When nutritional information was included in fast food restaurants, it resulted in parents feeding their children 102 fewer calories. Despite this, the parents themselves continued to maintain their caloric intake, a finding consistent with other studies that demonstrates that caloric information provides little in terms of calorie intake or restriction (Tandon et al., 2010). Other researchers point to the possible strategy of changing the size of utensils and plate size to help reduce consumption levels (Sobal & Wansink, 2007). Unfortunately, serving size norms and expectations are likely to override the effect of smaller plates and silverware (Sobal and Wansink, 2007).

Harnessing environmental cues for the purpose of weight loss is in its infancy. There are few studies to date that suggest there may be utility in using the environment to change specific behaviors for the better (Kerr, Eves, & Carrol, 2001; Wansink & Sorbal, 2007; Papies & Hamstra, 2010). Yet, recent research does encourage the study of such environmental factors (Goldschmidt e tal. 2017). Additionally, the concluding remark by Biswas, Szocs, Chacko, and Wansink (2017) points to environmental effects of eating, suggesting that simple manipulations such as brighter lighting may lead to healthier food choices (though this hypothesis was not directly tested).

With respect to behavior changes, one interesting intervention used "point of decision prompts" to promote stair use when alternatives, such as elevators, were previously utilized by the majority of persons observed (Kerr, Eves & Carroll, 2001). In this study it was found that posting a sign describing the benefits of stair use actually increased the number of people who used the stairs and decreased the number of people who used the elevator. It was also noted that the size of the poster was important – the larger the poster, the more effective – as was the gender of the person reading the sign – males took the stairs more often when the sign was posted (Kerr, Eves & Carroll, 2001). A second study aimed more specifically at the use of environmental cues to reduce eating behaviors found that leaving bones of consumed chicken wings on a table decreased the amount of total food consumed by the patrons (Wansink & Sorbal, 2007). These effects were also more pronounced in males than females. The researchers concluded that environmental cues may provide an effective means of reducing consumption (Wansink & Sorbal, 2007). One study has posed a possible use for environmental cues to prime reduced eating (Papies & Hamstra, 2010). However, the priming cue to reduce food consumption was only effective for participants who were made conscious of their need to follow a particular diet. Participants without the dieting cue were unaffected by the cue to reduce food consumption.

Despite the limited scope of research with regards to using the environment to aid weight loss, it does provide some very clear starting points. Specifically, we hypothesize in this study that weight loss efforts may indeed be enhanced with the use of environmental factors or cues. We examined the effects of environmental cues on weight gain/loss in 105 adult college students. The use of easily-accessible cues were employed and combined with an eight-week weight loss program to elucidate the effects of environmental cues on managing body weight.

### *Procedures*

The hypothesis that environmental cues may be used to enhance weight loss was examined using a design similar to research that incorporated visual cues to successfully encourage increased levels of exercise in human participants (Kerr, Eves, & Carroll, 2001). For this study, we employed visual cues that were provided to the experimental group participants. A recent finding (Boswell & Kober, 2016*)* demonstrated visual cues to be as powerful as actual food in leading to excess food consumption, thus we concluded visual cues would be the most salient stimuli. The cues used were portable and could be placed wherever participants determined they would be the most effective. The specific procedures of how this was accomplished are detailed below. Following the Human Subject Review Boards approval of our protocol, researchers recruited a total of 141 participants through the use of announcements made via weekly published student news emails as well as general campus email announcements. Participants were informed of the purpose of the study (weight loss assistance) and read and signed an informed consent form detailing their role in the project and their right to withdraw at any time. To be included in the analysis, participants must have completed at least half of the counseling sessions including the initial and final meeting. Out of the 141 original participants, 105 met the above described criteria.

Therefore, our total number of participants included only this group of 105 participants. Participants were predominately female (78%) and were distributed almost evenly among 1st year, 2nd year, 3rd year and 4th year college students (freshman to seniors). Each participant selected a meeting time that best suited their schedule. Participants met once per week with one of eight counselors. The eight counselors were trained to assist participants in their weekly meetings, which served to hold both control and experimental participants accountable for their weight loss behaviors. Participants who requested a certain gender as their counselor were accommodated and participants remained with the same counselor throughout the study. The counselors for this project were trained to interact with participants in the same consistent manner at each meeting. For example, each week participants were weighed, then asked to set weekly goals, which included: weekly weight loss goal, behavioral changes, food consumption changes, and other changes of the participants choosing (example: reducing stress, watching less television, etc). Participants were instructed to set specific behavioral goals, which could include changes in exercise, eating patterns, or other suggestions, such as walking to class instead of driving. Each participant was given a different handout each week that discussed various aspects of weight loss. Providing information only has not been demonstrated to be a useful tool for weight management (Berman, and Lavizzo-Mourey, 2008; Tandon et al., 2010). Participants that missed a meeting were provided with the handouts they did not receive via email to insure that all handouts were distributed. We therefore did not evaluate the impact of informational material on weight loss. The length of each meeting was limited to 30 minutes per weekly session.

All participants had an initial meeting with their counselor. In this meeting, they were asked to set goals for their weight loss and also not to discuss the details of their weight loss strategies with anyone else until the study was complete. No handouts/readings were given in this first meeting (week 1). Each participant's second meeting with a counselor (week 2) signified the beginning of the actual experiment and participants were randomly placed into either the control group or the experimental group.

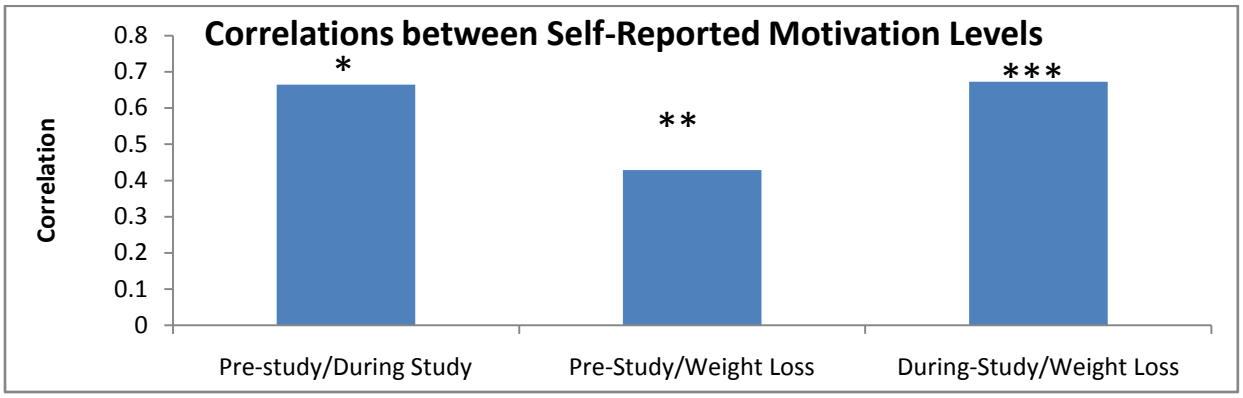
All participants had the identical above mentioned interactions with their counselor. The only difference between the two groups was that the experimental group received environmental cues intended to remind them of their weight loss program. The specific selection of the cues used in our study was based on pilot data with 12 volunteers who were either given the cues or not (n=6 for each group) to assist in their weight loss efforts. The cues consisted of 10 colorful, removable stickers (5cm x 10cm) containing words or phrases intended to remind the person of their weight loss goals. The use of multiple cues allowed each subject to locate the cues where they would be seen frequently. Locations chosen by participants included: on their debit/credit cards, on car steering wheels, on bathroom mirrors, on refrigerators, and even on specific foods such a potato chip bag. The messages on the stickers varied. For example, some read, "You can do it!", "Stop! Back away from the chips!", "It takes an hour of exercise to burn this off!", "Do you really need that?", and so on. Participants in the pilot study were weighed, met with a trained counselor and received the same handouts used in this current study once a week for 8 weeks. Data from the pilot study revealed a noticeable increase in weight loss with the use of the cues. Therefore, similar cues were used in this current study (i.e. experimental group members were given ten stickers following their first body weight measurement with a counselor on week 2). The phrases/words on the cues were found to be irrelevant, thus no words or phrases were placed on the cues for the current study (participants were free to write on the cues if they chose to do so). The critical stimuli appears to be simply the presence of the cue (sticker). The ability to place the cues wherever a subject wanted them was deemed a useful procedural approach, given the potential variety of environments our participants may live and interact within. Limiting the placement of cues to predetermined locations may have reduced or eliminated their effectiveness.

During the third meeting with their counselor, participants were allowed to request additional stickers. Experimental subject were limited to a maximum of twenty cues (stickers). Of our 51 experimental subjects, only 2 requested additional stickers. For the remainder of the study, counselors continued to weigh participants, set goals, and provide handouts. The data from the two groups was tracked weekly by counselors for total weight loss and participation. Additional data collected included self reported motivation to lose weight and past success at weight loss. All participants returned to our lab one week following the end of the study to receive debriefing and to discuss their overall progress and perception of the study.

### *Results*

Data analysis was primarily focused on the changes in body weight between the two groups. Additionally, self reported motivation to lose weight was examined in combination with participation (how many meetings attended). Participants estimated their level of motivation to lose weight prior to the study using a Likert scale of 1 through 7 with higher numbers indicating a higher level of motivation. Also, at the conclusion of the study, each subject completed a questionnaire which asked them to self-report their levels of motivation during the research project. This allowed an evaluation of different motivational levels and accompanying levels of success between the two groups. The correlations between amount of weight loss and motivation were analyzed using Spearman's rho statistical test and are depicted in Figure 1.

**Figure1.**




*rho(103)=0.665 (p=0.0003); ** rho(103)=0.429 (p=0.03); ***rho(103)=0.673 (p=0.002)

The level of self-reported motivation was statistically significant for all three comparisons. In this study there are strong correlations between level of motivation to lose weight and actual weight loss.

Self-reports, while useful, may not always provide reliability and accuracy. We therefore examined an additional variable that may indicate level of motivation based on behavioral data. The number of meetings attended for each participant was divided by the total number of meetings possible during the study to produce a participation ratio (p.r.). Each participant had chosen their meeting time to insure there were no conflicts during the eight-week program. Participants who missed two or fewer meetings were termed "high participation". Those who missed two to four meetings were deemed "low participation". The weight lost by these 2 groups was then compared (see Table 1). This participation data shows a significant difference for the amount of weight lost between the two groups. While there is no significant difference between those with high participation, the low participation data does reveal a significant difference. Specifically, the data indicates that level of motivation as self reported and using behavioral measures (participation) is an important factor in weight loss, but the use of environmental cues was able to compensate for low participation.

**Table 1.**

| | Total | | High Participation | | Low Participation | |
|---|---|---|---|---|---|---|
| | p.r. | *Weight lost* | p.r. | *Weight lost* | p.r. | *Weight lost* |
| Control | 0.907 (n=54) | *1.54* | 0.982 (n=42) | *1.88* | 0.646 (n=12) | ***0.33*** |
| Experimental | 0.926 (n=51) | *2.8** | 0.991 (n=41) | *2.85* | 0.663 (n=10) | *2.6** |
| | | *t(103);p=0.045 | | t(81);p=1.88 | | *t(20);p=0.047 |

* Indicates statistically significant difference

There were no significant differences within the control or experimental groups (high versus low participation)

p.r. = participation ratio (# of meetings attended/total # meetings)

The main variable of interest was the total amount of weight loss (See Table 2). Participants either had the environmental weight loss cue (experimental group) or no cues (control group), but all participants received weekly counseling sessions to discuss weight loss and set weekly goals. Thus, it was expected that both groups would lose weight during the study, however the independent variable was hypothesized to lead to more weight loss. The cumulative mean weight loss for the control group was 1.54 pounds during the eight-week program while the experimental group lost an average of 2.80 pounds (t= $p<0.05$, df(103)).

**Table 2.**

| | Start Weight | End Weight | Weight Loss |
|---|---|---|---|
| Control | 173.67 lbs | 172.13 lbs | 1.54 lbs |
| Experimental | 178.06 lbs | 175.26 lbs | ***2.8 lbs** |

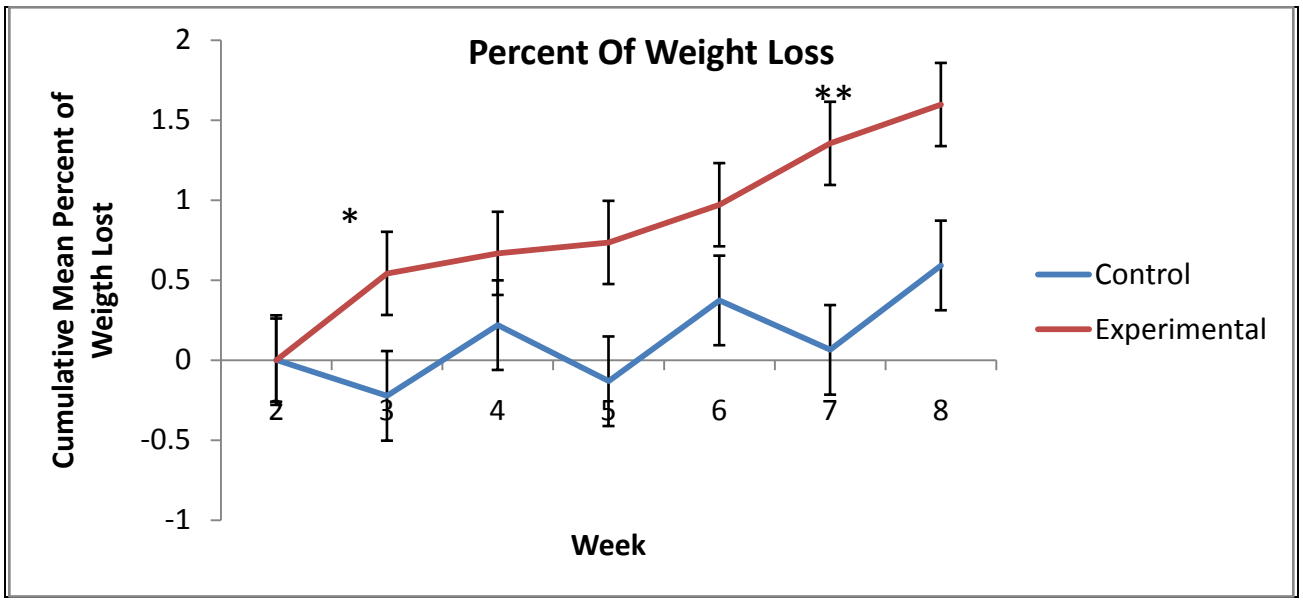
Note: 0.467 pounds/week mean weight loss for the Experimental group

0.256 pounds/week mean weight loss for the Control group

*** Significantly Different, t(103);p=0.045**

When examining the data it is curious to note that the control group actually gained weight during weeks 3 and 5 (see Figure 2). In contrast, the experimental group showed a monotonically increasing weight loss each week, culminating in a higher total amount of weight lost for the study. During weeks 3 and 7 the difference between the two groups was statistically significant. In fact, the experimental group had more mean weight loss on every week with the exception of the final week. Data are presented as a percent of weight loss to account for differences in total body weight (Figure 2).

**Figure 2.**




*Significantly different t(103);p=0.0388; ** t(103); p=0.047)

### *Discussion*

The obesity rates for many developed countries have created what the Centers for Disease Control, the Surgeon General, and the American Medical Association have referred to as an Obesity Epidemic (Stein and Colditz, 2004). The factors contributing to this epidemic have been debated and are typically categorized as: genetic/physiological, behavioral/learned, and social/cultural. While many scientific contributions have furthered our understanding of how our bodies respond to the presence and absence of nutritional factors (Crum, Corbin, Brownell, & Salovey, 2011; Lustig, Badman and Flier, 2005; Rosenheck, 2008; Schmidt, & Brindis, 2012; Young, 1986), the basic question of why we have become so obese in such a short time has yet to be agreed upon (Caballero, 2007; Brownell and Wadden, 1992). Unraveling human physiology or genetics to determine the source of the sudden rise in obesity seems to be an appropriate path to undertake. However, human physiology and genetics have likely changed very little over the past 40 years while obesity rates have tripled. To put it plainly, if we focus on physiology we may be looking for explanations for increased obesity in the wrong place. Probing environmental factors may prove to be more efficacious. For example, technological advances have altered our lifestyles including our meal preparation, transportation, and recreation. Entire areas of research now focus on a concept referred to as the "built environment" (Gordon-Larsen, Nelson, Page, & Popkin, 2006; Papas, Alberg, Ewing, Helzlsouer, Gary, & Klassen, 2007). Such research examines how our cities, towns, and building have been constructed for our convenience and perhaps led us to become a more sedentary population (Cohen, 2008). In the research provided here, we have begun to address the hypothesis that environmental factors, while certainly contributing to the current epidemic rates of obesity, may be capable of reversing the problem. If our environment is indeed contributing to obesity, then it should be possible to use these same factors to reduce obesity. We have demonstrated in this study that simple environmental cues can influence participants to alter their behaviors in such a way that significantly more weight loss occurs compared to participants who do not have these same environmental cues. It is especially encouraging to note that the use of visual cues in our experimental group resulted in a consistent week to week weight loss (and not simply a large drop followed by no weight loss). Thus, the cues may be helpful in sustaining weight loss behaviors.

Additionally, the effect of motivation/participation on weight loss was observed. Though motivation was self reported, we also used participation rates as a way to help quantify motivation. We reasoned that the less motivated individuals would not participate in the program as completely as the more motivated participants. These participation rates allowed us to infer motivation based on how consistently participants attended their weekly sessions. In the control group, a notable difference in total mean weight loss is seen when comparing the participants with high versus low participation ratios. It is important to note that the visual cues were associated with similar weight loss regardless of motivation/participation level. In other words, using the visual cues lead to results similar to highly motivated participants. This indicates that environmental cues may be used to enhance weight loss, even of persons demonstrating few behaviors associated with successful weight management. While the experimental group consistently lost weight each week, the control group actually had two weeks where the mean body weight increased. However, the control group also had the largest single week weight loss recorded in the study which occurred on the final week. We hypothesize that this result was also associated with environmental factors. Specifically, we suggest that the end of the study served as a salient cue for both groups. The control group, having very little weight loss, may have altered their behaviors with the impending end of the study. The experimental group with its consistent weight loss experienced the same end of study cue, but had no reason to change behavior. Thus, the data reveal not only a role for a positive, salient visual cue that can enhance weight loss, but also the influence of large salient cues that exist in our environment (other examples may include an upcoming wedding, class reunion, job interview, holidays, etc.).

To conclude, salient environmental cues are shown here to enhance weight loss. While the evidence supporting the role the environment plays in inducing excess eating in our population is well established, evidence here points to the ability of environmental cues to be useful in counteracting these effects. More research is warranted in this area to elucidate the role that environmental influences may play in enhancing overall human health. While our findings are provocative, it is suspected that even more substantive findings may be uncovered with a larger subject pool of the typical weight loss demographic (adults over the age of 25 and with BMI's in excess of 26). There would also be interest in replicating this research in varied settings, such as in home environments, without the use of counselors, or coupled with other weight loss strategies or programs. Finally, the experiment should be carried out over a longer period of time.

Sustained weight loss of 6 months is not uncommon, but maintaining weight loss over a longer period is rare. Thus, we are currently proposing a 2 year longitudinal study of weight loss using environmental cues as the critical independent variable. Finding a simple, sustainable solution to the obesity epidemic is optimistic, but perhaps within our reach.

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