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“Memory Bias” for Recall of Experiences During Initial Weight Loss Is Affected by Subsequent Weight Loss Outcome

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Abstract

Research has suggested that memories of mood, emotions, and behaviors are not purely unbiased retrieval, but more similar to reconstructions based on current opinions, positive or negative experiences associated with the memory, and how a person believes they would have felt, thought, or acted. We investigated this memory bias in 66 adult participants with overweight/obesity who rated their mood, emotions, and behaviors during a 12-week, Internet-based behavioral weight loss program and later recalled these ratings at Month 3 (immediate post-test) and Month 12 (follow-up). At Month 3, participants recalled the intervention more positively than reported previously, $p=.010$, but reported remembering the intervention more negatively at the Month 12 follow-up, $p=.004$. Memory bias was associated with initial weight loss and regain, $ps<.05$, such that participants who lost more weight at Month 3 remembered their mood, emotions, and behaviors during intervention more positively, and those who regained more weight at Month 12, more negatively. Future research should investigate whether this bias is associated with willingness to re-engage with intervention.

Keywords

Obesity; Behavioral Weight Management; Weight Regain; Memory; Retrospective Data Collection

Introduction

Although developments in technology and data collection methods (e.g., ecological momentary assessment methods [EMA]; Shiffman, Stone, & Hufford, 2008; Arthur A. Stone

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Compliance with Ethical Standards

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Conflicts of Interest: Intervention content used in the parent study has been licensed to commercial partners by RRW. KMR and RRW were employees of Lifespan at the time of initial intervention provision and data collection.

& Shiffman, 1994) have allowed for more “real-time” data capture, behavioral health interventions continue to rely heavily on retrospective self-report questionnaires for data collection. In addition to potential issues with confounds such as social desirability (Krumpal, 2013; Sitzia & Wood, 1997), these measures may also be impacted by other cognitive biases. Specifically, several researchers have suggested that individuals’ memory of past mood, emotions, cognitions, and behaviors are more similar to reconstructions (based on current opinions and behaviors and thoughts of how a person believes they would have felt, thought, or behaved) than pure retrieval (Dwyer & Coleman, 1997; Kihlstrom, Eich, Sandbrand, & Tobias, 2000; Levine, 1997; Levine, Lench, & Safer, 2009; Levine & Safer, 2002; Matt, Vázquez, & Campbell, 1992; Robinson & Clore, 2002b, 2002a; Singer & Salovey, 1993). Memory for both dietary intake and physical activity, for example, has been demonstrated to be affected by “intrusions” based on eating and activity patterns at the time of recall (Durante & Ainsworth, 1996; Dwyer & Coleman, 1997). Further, a recent study using EMA methods (collecting “real time” data using smartphone prompts) found that negative emotional states did *not* predict dietary lapses (Forman et al., 2017). Since this contrasts with previous research (based on data collected using retrospective measures), the authors suggested that the results from the previous studies may have been biased due to participants accounting for behaviors not consistent with their intentions. Taken together, these results suggest that questionnaires asking participants to provide retrospective data at the end of treatment (or at later follow-up assessment visits) regarding their experiences during a health behavior change intervention may be biased by more salient factors such as their current treatment outcome (e.g., if they achieved and maintained positive health behavior change or if they regressed to previous health behaviors).

Two studies have demonstrated that memories for previous mood, cognitions, and behavior during a behavioral health intervention may be impacted by treatment outcome. First, a study in the smoking cessation literature demonstrated that participants who were not abstinent from smoking for the two weeks prior to a follow-up assessment were more likely to overestimate both negative affect and the numbers of cigarettes that they had smoked during a lapse that had occurred 12 weeks prior to the assessment (Shiffman et al., 1997). Second, in the weight management literature, Wadden, Stunkard, and Smoller (1986) observed that retrospective scores on measures of both depression and trait anxiety conducted 18 months after the end of a weight loss program for adults with obesity were higher than those measured at immediate post-test, and further that participants who lost less weight during the initial treatment exhibited more negative bias in their retrospective depression scores.

Given the documented tendency for individuals to regain weight after the end of weight management treatment (Jeffery et al., 2000; National Heart, Lung, and Blood Institute, 1998), it is important to conduct further investigation into whether weight regain affects memory for prior program participation. Further, it is important to know whether this pattern exists for non-clinical measures (e.g., general positive and negative affect, emotions, or memory of behaviors during the intervention). Thus, the current study examined the existence of this memory bias by measuring mood, emotions, and behaviors weekly during a 12-week behavioral weight management intervention and then asking participants to recall their ratings of these items at later study assessment time points. We hypothesized that

participants would demonstrate biased recall of previous mood, emotions, and behavior at the Month 3 post-test and Month 12 follow-up assessments, and that this bias would be associated with weight loss outcome (i.e., initial weight loss baseline to Month 3 and weight regain Month 3 to Month 12).

Method

Participants

The current study was a secondary data analysis of data from an Internet-based behavioral weight management intervention implemented in a worksite setting (Ross & Wing, 2016). Participants were 75 employees (or dependents of employees) who worked for a large healthcare corporation in Providence, RI. Participants were included if they were aged 18–70 years old, had a BMI between 25 kg/m² (but a weight below 150 kg due to the provision of in-home scales with this weight limit), had a computer/Internet at home, and had enrolled in their workplace's healthcare rewards program and indicated interest in weight loss. Potential participants were contacted through e-mails, texts, and advertisements on the employer's intranet. If interested, participants were asked to complete an online pre-screen questionnaire and attend an in-person orientation visit. Informed consent was obtained from all participants included in the study. Full inclusion/exclusion criteria and study protocol are available in the main study article (Ross & Wing, 2016). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments.

Intervention

All participants were provided with a 12-week, Internet-based behavioral weight management program adapted from materials and protocol of the Diabetes Prevention Program (Diabetes Prevention Program (DPP) Research Group, 2002) and Look AHEAD (The Look AHEAD Research Group, 2003). Participants were asked to attend a one-time, in-person group visit to receive basic education regarding weight management. At this visit, participants were introduced to the study website and given tailored calorie, dietary fat, and physical activity goals. Participants were then asked to log into the website each week for 12 weeks to view an interactive multimedia weight management lesson and to report self-monitoring data. After the 12-week intervention, participants were asked to continue to log in to the study website each week to answer a weekly questionnaire and provide self-monitoring data; however, participants no longer had access to the intervention components (multimedia lessons and feedback on self-monitoring) that were provided during the initial intervention. A complete description of the methods and intervention has been published previously (Ross & Wing, 2016).

Measures

Each week during the 12-week intervention, participants were asked to log in and report their weekly self-monitoring data. At the same time (as part of the same website form), participants were asked to answer 11 Likert-style questions on mood, emotions, and behaviors during the previous week (e.g., "How positive was your mood during the past

week?” ranked 1 to 7, with 1 = not positive at all and 7 = very positive). To improve adherence to the weekly reporting of data, participants were given small financial incentives (ranging from \$1 to \$10 per week, on a schedule unknown to the participants) for completion of the online questionnaire. Further, at the post-test (Month 3) and follow-up (Month 12) assessment visits, participants were asked to “think back to how [they] felt during the 12-week Internet weight management program” and respond to each question as they would have responded during the program (e.g., “How positive do you remember your mood being during the 12-week program?”).

Demographic data were collected at the baseline assessment visit using a self-report questionnaire. Height and weight were collected by trained research assistants, with participants in light, indoor clothing and with shoes removed. Height was measured at the baseline assessment visit to the nearest 0.1 cm using a wall-mounted stadiometer. Weight was measured to the nearest 0.1 kg at each assessment visit using a calibrated digital scale.

Statistical Analyses

All analyses were performed in SAS Version 9.4 (SAS Institute Inc., 2013). The mood, emotion, and behavior ratings from the 11 Likert items were averaged by item across the 12-week weight management program. Descriptive statistics were used to investigate means and standard deviations of these averaged items during initial treatment and the memory of previous self-report of these items at Months 3 and 12, and t-tests were used to assess differences between initial ratings and retrospective recall of ratings. Summary scores of memory bias across all 11 items were created by subtracting the averaged self-report ratings of the 11 items from the memory of these ratings at Month 3 and Month 12, respectively, and then summing the total discrepancy at each time point. During the creation of these two summary scores, 7 items were reversed scored (negative mood, stress, hunger, boredom with weight control efforts, temptation to eat foods not consistent with weight management goals, temptation to skip planned physical activity, and the amount of effort it took to stay on track with goals) so that positive scores on the summary score indicated retrospective recall more positive than initial responses. Finally, linear regressions were used to examine the association between percent weight loss baseline to Month 3 and memory bias at Month 3, and the association between percent weight regain Months 3 to 12 and memory bias at Month 12.

Results

Of the 75 participants from the larger intervention study, 9 were excluded from analyses due to missing assessment data at follow-up visits. There were no differences between included and excluded participants for age, baseline weight, baseline BMI, or race/ethnicity; however, participants not included in the current analyses had lower educational attainment than those who completed the assessment visits (see Table 1). There was further no difference between included and excluded participants in terms of percent weight change from baseline to Month 3, $p = .131$.

Participants lost, on average (mean $\pm$ SD) $-6.69 \pm 4.85\%$ of their initial body weight during the 12-week intervention, and experienced a weight regain of $2.93 \pm 4.60\%$ from Month 3 to

Month 12 (total change from baseline to Month 12 was $-3.92 \pm 7.03\%$). Mean BMI at Month 3 was $29.19 \pm 4.27 \text{ kg/m}^2$ and at Month 12 was $30.05 \pm 4.59 \text{ kg/m}^2$.

Table 2 presents average scores for the 11 items assessed weekly during the program and memory for these scores at Months 3 and 12. During the intervention, within-individual variability from week-to-week was low (average of 1.16 ± 0.09 across items); thus, averaging item data across 12 weeks appeared appropriate. Overall, there was evidence of a positive memory bias at Month 3, such that participants remembered their mood, emotions, and behavior during the program more positively than reported during the intervention, mean $\pm$ SD memory bias summary score = 1.77 ± 5.43 , $t(65) = 2.65$, $p = .010$, $d = 0.33$. In contrast, at Month 12, participants exhibited a significant negative memory bias, memory bias summary score = -3.56 ± 9.66 , $t(65) = 3.00$, $p = .004$, $d = 0.37$.

There was a significant association between percent weight loss baseline to Month 3 and memory bias summary score at Month 3, such that individuals who lost more weight demonstrated less negative bias, $F(1,64) = 11.89$, $p = .001$, $\beta = -.442$, $R^2 = .157$. To further explore the impact of weight loss from baseline to Month 3 on memory bias, participants were split into two categories based on whether they met (or did not meet) the Institute of Medicine's (1995) cut-off for clinically-significant weight loss (weight loss $\geq 5\%$ from baseline). Participants who lost $\geq 5\%$ of their baseline weight at Month 3 had a memory bias score of 3.31 ± 4.39 , compared to a score of -0.92 ± 6.08 for those who did not meet this clinical cut-off. Descriptively, Figure 1A demonstrates that this trend was documented across items, with the exception of temptation to skip planned physical activity and how consistent participants remembered their activity being with their physical activity goals.

Similarly, percent weight regain from Month 3 to Month 12 was significantly associated with the memory bias summary score at Month 12, such that individuals who experienced higher weight regain were more likely to remember their time during the intervention more negatively than actually reported during the intervention, $F(1,64) = 6.05$, $p = .017$, $\beta = -.618$, $R^2 = .086$. To further explore the impact of weight regain from Months 3 to 12 on memory bias, individuals were categorized by established clinical cut-points (Stevens, Truesdale, McClain, & Cai, 2005). Participants who experienced weight changes of $\geq 3\%$ from Month 3 to Month 12 were considered to have regained weight ($n = 34$; mean weight change = $6.06 \pm 3.63\%$) while those who experienced weight changes of $< 3\%$ were considered successful weight loss maintainers ($n = 32$; mean weight change = $-0.40 \pm 2.83\%$). At Month 12, participants who experienced clinically-significant weight regain had a memory bias score of -4.58 ± 10.15 , compared to a score of -2.48 ± 9.14 for successful weight-loss maintainers. Descriptively, Figure 1B demonstrates that this pattern existed across items, with the exception of the memory of the effort required to stay on track with weight management goals. There was not a significant association between 3 month memory bias summary score and weight regain from Month 3 to Month 12, $p = .910$ (i.e., memory bias at Month 3 did not predict weight regain), and there was not an association between BMI and memory bias summary score at Month 3 or Month 12, $ps > .05$. Finally, while not a significant association, there was a trend for individuals who had higher (i.e., more positive) memory bias summary scores at Month 3 to also have higher scores at Month 12, Month 12, $r = 0.24$, $p = .052$.

Discussion

The current study demonstrated bias in the retrospective recall of mood, emotions, and behaviors when compared to self-report data collected during a weight management intervention. Results demonstrated that, at immediate post-test, participants reported remembering their mood, emotions, and behaviors during initial treatment more positively than reported at the time, whereas at Month 12 follow-up, participants reported remembering their mood, emotions, and behaviors during initial treatment more negatively than originally reported. In particular, as demonstrated in Table 2, there were significant positive biases at Month 3 for positive mood, temptation to eat foods not consistent with goals, consistency of eating/activity with goals, and the importance of staying on track, but none of these remained significant at Month 12 (temptation and behavioral consistency became more accurate at Month 12, while importance at Month 12 was significantly *worse* than measured during the intervention). Further, at Month 12 there were negative biases for stress, hunger, boredom, and the effort required to stay on track, but not negative mood (suggesting that negative memory bias may have a greater impact on program-specific cognitions and behaviors than on overall mood).

The current results additionally demonstrated an association between memory bias and weight loss outcome, such that participants who lost the most weight during the 12-week intervention experienced the highest positive memory bias at Month 3, and participants who regained the most weight between Month 3 and Month 12 experienced the highest negative memory bias at Month 12. These findings were consistent with other studies in the memory literature and results of Wadden and colleagues (1986); however, we demonstrated that this bias may be broader across treatment-related memory than previously identified, extending results to non-clinical measures of mood, emotions, and behavior. The small effect sizes for analyses assessing the contribution of weight change to bias at Month 3 and Month 12 suggest, however, that more research should be conducted to identify additional subgroups that may have higher levels of memory bias (beyond categorization by treatment outcome).

The current results have important implications. First, they suggest that measurement time (e.g., immediate post-test vs. later follow-up) of retrospective recall of prior mood, emotion, and behavior may lead to either over or under-estimation of how these items would have been rated during the intervention. Thus, researchers should be wary of using only retrospective recall methods to gather these data and should focus on collecting more “real-time” data during initial intervention (Shiffman et al., 2008) or limit self-report to concurrent, cross-sectional measures (e.g., measuring *current* mood, emotions, or behaviors at follow-up assessment points).

Another point of consideration is how negative memory bias may affect future behavior, especially given that changing health behaviors often requires multiple attempts. Research in decision-making has found that an individual’s choice to re-engage in an activity is highly influenced by their memory of previous affect and how enjoyable they remember the activity being (Klaaren, Hodges, & Wilson, 1994; Wirtz, Kruger, Scollon, & Diener, 2003); this research suggests that participants who remember prior behavior change efforts more negatively may be less to make future attempts at that behavior change. For example,

individuals remembering their time during a weight management intervention more negatively than reported during the program (and those who regain the most weight remember their time the most negatively) may have lower willingness to re-engage with treatment. Indeed, recent research in physical activity has demonstrated that, compared to *experienced* affect (measured during exercise), only *remembered* affect was associated with subsequent exercise behavior (Kwan, Stevens, & Bryan, 2017).

Finally, while the current analyses did not demonstrate an association between BMI and memory bias, other studies have demonstrated that obesity may be related (at least in cross-sectional data) to deficits in cognitive functioning (Cheke, Simons, & Clayton, 2016; Coppin, Nolan-Poupart, Jones-Gotman, & Small, 2014; Prickett, Brennan, & Stolwyk, 2015; Smith, Hay, Campbell, & Trollor, 2011). Further, recent reviews have demonstrated that weight loss produced by either dieting or bariatric surgery may improve cognitive functioning, including memory (Handley, Williams, Caplin, Stephens, & Barry, 2016; Veronese et al., 2017). Future studies should investigate whether memory bias may be related to more broad changes in cognitive functioning.

Strengths of the current study include the inclusion of a range of items assessing mood, emotions, and behavior during treatment and at later follow-up points (rather than just assessing overall program satisfaction or using a single clinical measure), the use of both concurrent and retrospective data collection, and minimal attrition. Limitations to the current study include generalizability (participants were predominately white, female, and highly-educated) and the use of unvalidated measures of mood and emotion. As we collected weekly self-report data, however, we were limited by potential participant burden; using full, validated measures for each mood and emotion construct would have likely negatively impacted adherence to completion of the questionnaire each week. Further, the study by Wadden and colleagues (1986) demonstrated a similar pattern of results with validated and reliable clinical measures of depression and anxiety, demonstrating that this effect is likely not an artifact of the measures used. An additional limitation is the large number of statistical tests used; however, this was an exploratory study and existing research did not provide guidance on which factors may be most susceptible to memory bias, thus we created items to capture a range of constructs. Finally, as we only investigated the association between weight regain and negative memory bias, future studies should examine other potential drivers of this effect (e.g., depression).

Conclusion

The current study demonstrated bias in retrospective recall of mood, emotions, and behavior at later follow-up assessment visits compared to measures collected during initial weight management treatment, and further demonstrated that this bias was associated participants' weight loss outcome. Future studies should investigate whether memory bias may have an impact on willingness to re-engage in lifestyle weight management treatment.

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Figure 1.
Difference between memory for mood, emotions, and behavior and scores measured during intervention, by weight change from baseline to Month 3 and Month 3 to Month 12.

Table 1
Baseline and demographic characteristics of included and excluded participants.

Variable	Included (n=66)			Excluded (n=9)			p
	M	SD		M	SD		
Age	50.73	10.60		51.00	9.14		.942
Baseline Weight (kg)	87.10	17.07		81.43	14.16		.345
Baseline BMI (kg/m ²)	31.33	4.65		30.31	2.91		.527
	n	%		n	%		
Race							.812
Asian	2	3.03		0	0.00		
Black/African-American	5	7.58		1	11.11		
White	55	83.33		8	88.89		
Other/Multiple	4	6.06		0	0.00		
Ethnicity							.773
Hispanic/Latino	2	3.03		0	0.00		
Not Hispanic/Latino	64	96.97		9	100.00		
Education							< .001
High School	4	6.06		2	22.22		
Vocational Training/Some College	10	15.15		6	66.67		
College/University Degree	33	50.00		1	11.11		
Graduate or Professional Education	19	28.79		0	0.00		

Table 2

Means ($\pm$ standard deviations) of self-reported mood and emotions during initial intervention, and memory for mood and emotions at Month 3 and Month 12 follow-up assessment visits.

Item	Memory of Mood/Emotion					
	Intervention		Month 3		Month 12	
	M	SD	M	SD	M	SD
Positive Mood	4.86	0.81	5.14	1.16 ^a	4.74	1.50
Negative Mood	3.01	0.91	2.85	1.32	3.05	1.37
Stress	4.01	1.17	4.26	1.60	4.44	1.53 ^a
Hunger	4.02	1.14	3.91	1.51	4.30	1.42 ^b
Boredom with weight control efforts	3.09	1.10	2.89	1.46	3.68	1.85 ^a
Temptation to eat foods not consistent with goals	4.80	1.25	4.50	1.50 ^a	4.82	1.61
Temptation to skip planned physical activity	3.57	1.59	3.80	2.10 ^b	4.36	2.17
How consistent was eating with goals	4.34	1.11	5.02	1.23 ^a	4.29	1.54
How consistent was activity with goals	4.57	1.35	4.89	1.67 ^b	4.15	1.99
How much effort it took to stay on track with goals	4.78	1.05	4.95	1.51	5.18	1.61 ^b
Importance of staying on track compared to other demands	5.16	1.17	5.53	1.42 ^a	4.73	1.89 ^b

Note: Values in the Intervention column represent an average across 12 weeks of ratings

^a denotes $p < .01$ and

^b denotes $p < .05$ between memory for an item and the actual measurement during intervention