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A *health/media literacy intervention improves adults' interpretations of sugar-sweetened beverage advertising*

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ABSTRACT

Although excessive sugar-sweetened beverages (SSB) intake is linked to numerous adverse health consequences, media literacy interventions rarely address the influences of food and beverage marketing with a specific focus on adults. This randomized controlled trial study investigated (1) whether media literacy education modifies adults' perceptions of SSB advertising and (2) whether changes are moderated by health literacy. Results from the multilevel mixed-effects regression analyses with the intention-to-treat last-observation-carried-forward method showed that compared to MoveMore (a matched-contact comparison condition), SIP*smart*ER (an intervention condition) participants significantly enhanced their skillsets across media literacy domains (i.e., authors/audiences, messages/meanings, representation/reality) between baseline and 6-month follow-up. Baseline health literacy status did not moderate media literacy outcomes. Both low and high health literate participants improved their outcomes, suggesting that this media literacy intervention benefited adults regardless of their health literacy level. Results demonstrate the importance of cultivating critical analyses and strengthening adults' resistance toward SSB advertising.

Keywords: *adults, nutrition, food and beverage marketing, sugar-sweetened beverages (SSBs), sugar-sweetened beverage media literacy scale (SSB-ML).*

INTRODUCTION

Sugar-sweetened beverages (SSBs), including soda/pop, sports drinks, and sweet tea, account for approximately 7% of total energy intake in adults (Kit et al., 2013) and contribute to nearly half of the sugar consumed in Americans (Welsh et al., 2011). Overconsumption of SSBs has generated significant health impact, leading to a series of adverse health consequences, including obesity, hypertension, diabetes, and tooth decay (Bernabe et al., 2014; Cheungpasitporn et al., 2015; Greenwood et al., 2014; Imamura et al., 2015; Malik et al., 2013). Existing randomized controlled trials that promote healthy beverage choices continue to underscore the challenges of addressing SSB-related health risks in the adult populations (Chen et al., 2009; Hernández-Cordero et al., 2014; Tate et al., 2012; Vargas-Garcia et al., 2017; Zoellner et al., 2016).

Cross-sectional and experimental research has consistently shown that adults' perceptions of beverages are significantly associated with SSB consumption (Bogart et al., 2013; Hennessy et al., 2015; Rampersaud et al., 2014). More than 60% of the adults did not consider added sugar an important criterion when choosing beverages (Rampersaud et al., 2014). It is then not surprising to find that confusion about whether a specific beverage (such as 100 % fruit juice vs. diet drink vs. milk) contains added sugar is widespread (Rampersaud et al., 2014). Such confusion is further compounded by how adults perceive the 'healthfulness' of the beverages (Hennessy et al., 2015). Homemade beverages are perceived as "natural" and "healthy," despite the high sugar content (Bogart et al., 2013). These and other misperceptions impact both adult parents' and children's consumption of sweetened tea, fruit drinks, and sports drinks (Hennessy et al., 2015). These findings highlight the importance of demystifying adults' misperceptions to improve their identification and choices of healthy beverages for themselves and their family.

There is also a need to address how the food and beverage marketing contributes to such misconceptions. Cross-sectional and experimental research has shown food and beverage marketing directly and indirectly impacts adults' perceptions and behaviors (Hennessy et al., 2015; Koordeman et al., 2010; Ludwig & Nestle, 2008; Northup, 2014; Riskey, 1997; Scully et al., 2012). For instance, exposure to SSB commercials has led to an increase in soda consumption in female college students (Koordeman et al., 2010) and adult parents were reportedly misled by sport drinks commercials, thinking these drinks were healthy (Bogart et al., 2013). Further, adults consider products with health-related packaging labels (e.g., natural, gluten-free, antioxidant, and organic) to be healthier than those without (Northup, 2014). These studies not only demonstrate how adults are misguided by claims in food packaging labels and commercials but also underscore the importance of cultivating critical thinking skills in this specific population to dispel misconceptions attributed to food and beverage marketing.

Theoretical domains of media literacy

Critical evaluation of media messages is at the core of media literacy education. It is a promising behavior change technique that effectively enhances media-related outcomes (e.g., media knowledge, criticism, and perceived media influences) and behavioral outcomes (e.g., behavioral beliefs, attitudes, self-efficacy, and behavior) (Jeong et al., 2012). Media literacy is traditionally defined as "an individual's ability to access, analyze, process and produce media messages" (Aufderheide, 1993). Informed by major theoretical frameworks, media literacy activities are represented by three domains that examine: the purpose of media producers and their intent on targeting specific consumers in mind (Authors and Audiences), persuasive techniques and viewpoints (Messages and Meanings), and the omission of pertinent information and missing health components in advertisements (Representation and Reality) (Bazalgette, 1992; National Association for Media Literacy Education, 2013; Thoman, 2003; Thoman & Jolls, n.d.).

The significance of these domains is further highlighted in their relationship with behavior in both adolescents and adults (Chen et al., 2016; Primack et al., 2006; Primack & Hobbs, 2009; Primack et al., 2009) and in their potential for enhancing the rigor of evaluations by matching intervention content with theoretical domains, specific advertising context, and health outcomes (Bier et al., 2010; Phelps-Tschang et al., 2015; Primack et al., 2014; Shensa et al., 2016). While some media literacy assessments may not explicitly address these domains (Austin et al., 2005; Pinkleton et al., 2012; Pinkleton et al., 2007), their evaluation measures (e.g., advertising production knowledge and perceived media influences) correspond with the overarching definition of media literacy and overlap with these theoretical domains. This suggests a shared

understanding of the role media literacy education plays in enhancing discernment toward media messages.

Adults as media literacy participants

Despite the effectiveness of media literacy interventions and evidence that adults are persuaded by food and beverage marketing, there is relatively little emphasis on the adult population. Of the limited available research that recruited adults, most provided trainings to adults (i.e., parents or teachers) as a way to help children navigate through the complexity of advertising (Austin et al., 2018; Hindin et al., 2004; Powell & Gross, 2018; Scull & Kupersmidt, 2010). While adults are not the direct beneficiaries or the sole targets, these studies suggest adults have the capacity to become media literate (Hindin et al., 2004; Scull & Kupersmidt, 2010), while their first-hand experiences with food preparation may impact the way in which they interpret food advertisements (Peterson, 2012). For example, parents' recognition of media influences as well as media deconstruction skills (e.g., recognizing products, identifying target audiences, understanding the intent of advertising and its persuasive techniques, and pinpointing missing information) were improved as a result of the interventions. Austin et al. (2018) further showed in their family-based media literacy intervention report that parents increased the number of their discussions about nutrition labels with their children through enhanced expectancies for discussing food marketing strategies with their children and improved self-efficacy. These studies highlight the potential of cultivating adults' critical thinking skills toward media sources and content that may generate a positive impact on family's healthy dietary behaviors in the long-run (Austin et al., 2015).

Designing an intervention with adults' media management skills in mind should also consider participants' health literacy skills and their impact on outcomes of interest. Health literacy is defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services related to making appropriate health decisions" (U.S. Department of Health and Human Services, 2010). It is intrinsically connected to media literacy as both focus on individuals' ability to analyze, understand, and decipher complex messages. Evidence supports that health literacy is associated with significant health disparities (Nielson-Bohlman et al., 2004; Paasche-Orlow et al., 2004; Zoellner et al., 2011), in particularly, among those who have low health literacy. Low health literacy in adults, which is indicated by a decreased capacity to process and understand health information, contributes to poor nutrition outcomes (Carbone & Zoellner, 2012). Based on the available evidence in the relationships among health literacy, information sources, and medical decision-making (Reyna et al., 2009; Shieh et al., 2009), low health literacy may also impede adults' ability to distinguish nutritional facts from the persuasive appeals in food and beverage advertising. Individuals' responses to interventions, therefore, may be moderated by health literacy. Further, studying health literacy status as a potential moderator of nutrition-related outcomes and media literacy effectiveness is a direct response to the call from Carbone and Zoellner (2012).

The association between adults' misperceptions and their beverage consumption is a significant public health concern and these misconceptions are often shaped by food and beverage advertising. Interventions for adults could greatly benefit from addressing the persuasive effects of SSB advertising through carefully matching assessment to intervention design as well as considering the moderating effects of health literacy. This study analyzes secondary data from a randomized controlled trial and proposes:

Hypothesis 1: When compared to the *matched-contact comparison condition*, participants in the *intervention condition* will have greater increases in the overall SSB media literacy skillsets and across all three domains.

Further, an exploratory hypothesis was proposed to test the moderating power of baseline health literacy status:

Hypothesis 2: In the *intervention condition,* low health literacy participants will have greater increases in SSB media literacy skillsets compared to their high health literacy counterparts.

METHOD

Participants

We used active (e.g., community health workers, Corporative Extension workers, trained research assistants) and passive (e.g., flyers, newspaper advertisement, recruitment postcards) strategies to recruit participants from low socioeconomic neighborhoods located in a 14-county rural region in

southwest Virginia (Estabrooks et al., 2017). To be eligible for participation, participants had to be English-speaking adults over 18 years of age, who consumed greater than 200 SSB Kcals/day, who have no health constraints that interfere with physical activity, and had access to a telephone.

The final total number of participants was 296 after removing five pregnant women (either reported at baseline and/or at the 6-month follow-up) from a total of 301 adult participants recruited (81.4% female; 93% White, 44 % receiving Supplemental Nutrition Assistance Program [SNAP] and/or Women, Infants, Children [WIC] benefits). These 296 participants were randomized into either SIP*smart*ER, the primary intervention aimed at decreasing SSB consumption, or MoveMore, the matched-contact comparison condition aimed at increasing physical activity (Zoellner et al., 2014; Zoellner et al., 2016). Compared with the U.S. census data, enrolled participants represented the demographic profiles of the recruited regions in terms of age, race, ethnicity, and years of school (Estabrooks et al., 2017). See Table 1 for program participants' demographic characteristics using the original recruited number of 301 participants. There were no significant differences between SIP*smart*ER and MoveMore at baseline.

Table 1. *Demographic characteristics of enrolled participants at baseline and differences between SIPsmartER and MoveMore conditions among eight cohorts*

	All Participants (n=301) n (%)	SIP*smart*ER (n=155) n (%)	MoveMore (n=146) n (%)	Statistic[a] (*p*-value)
Gender				
Female	245 (81.4%)	109 (81.3%)[c]	107 (82.3%)	.84
Male	56 (18.6%)	25 (18.7%)	23 (17.7%)	
Race/Ethnicity				
White	280 (93%)	141 (91%)	139 (95.2%)	.15
Other	21 (7%)	14 (9%)	7 (4.8%)	
Education level				
< High School	96 (31.9%)	52 (33.5%)	44 (30.1%)	.53
> High School	205 (68.1%)	103 (66.5%)	102 (69.9%)	
Employment status[b]				
Employed	153 (50.8%)	44 (45.4%)	57 (60%)	
Unemployed	35 (11.6%)	12 (12.4%)	8 (8.4%)	.06
Other (*homemaker, student, retired, unable to work*)	113 (37.5%)	41 (42.3%)	30 (31.6%)	
Insurance				
Uninsured	104 (34.6%)	31 (32%)	29 (30.5%)	.87
Insured	196 (65.1%)	66 (68%)	66 (69.5%)	
Health literacy				
Low Health Literacy (*NVS 0-3*)	99 (32.8%)	57 (36.8%)	42 (28.8%)	.14
High Health Literacy (*NVS 4-6*)	202 (67.2%)	98 (63.2%)	104 (71.2%)	

[a] Comparison for SIP*smart*ER and MoveMore using Chi-Square tests.

[b] Numbers do not add up to 100% because participants could report multiple employment statuses.

[c] Some missing data were noted in the gender variable.

SIP*smart*ER and MoveMore conditions in the Talking Health trial[1]

Talking Health is a six-month, pragmatic randomized controlled trial, which consisted of two conditions: SIP*smart*ER and MoveMore (Zoellner et al., 2014; Zoellner et al., 2016). The Theory of Planned Behavior (Ajzen, 1991) and health/media literacy approaches (Aufderheide, 1993; Centers for Disease Control and Prevention, 2014; Golbeck et al., 2005; U.S. Department of Health and Human Services, Health Resources and Services Administration, 2007) guided the development of all intervention content. Application of health literacy concepts in Talking Health included

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[1] For an overview for the Talking Health trial structure, theoretical constructs, and content, see Zoellner et al. (2014).

numeracy, media literacy, oral literacy, print literacy, and cultural knowledge; however, there were also strong emphases on health numeracy and media literacy (Ancker & Kaufman, 2007; Aufderheide, 1993; National Association for Media Literacy Education, 2013; Reyna, et al., 2009).

Details about activity and content structure are described in the section below. All study procedures were approved by the Institutional Review Board and participants provided written informed consent.

Media literacy education and IVR messages in SIPsmartER and MoveMore

Participants in both SIPsmartER and MoveMore received three 90-minute small group education sessions, one 20-minute teach-back call, and 11 interactive voice response (IVR) telephone calls. For the purpose of this secondary data analysis, only the media literacy education in the second in-person small group session and two IVR calls that addressed media literacy concepts are discussed below.

Per the pragmatic, matched-contact comparison design, both SIPsmartER and MoveMore participants received media literacy related content three times: an IVR call in week 6, small-group class in week 7, and another IVR call in week 7-8. The comparison condition MoveMore matched the contact and structure of SIPsmartER, but focused on physical activity promotion. The media literacy addressed three theoretical domains: authors and audiences, messages and meanings, and representation and reality. Each activity also addressed Theory of Planned Behavior constructs, particularly behavioral intention.

Despite similarity in structure in both SIPsmartER and MoveMore conditions, the focus and intensity in each condition differed, however. For example, the health contexts varied based on the behavioral target of the condition: sugar-sweetened beverages or physical activity. SIPsmartER participants received 90 minutes of media literacy education compared to the 30 minutes that their MoveMore counterparts received.

SIPsmartER content

In the IVR call prior to the small group session (week 6), SIPsmartER participants were prompted to think about how media influence consumers' choices of sugary drinks. They were also asked to pay attention to the media messages and keep track of sugary drink commercials in their workbook. In the small group

session in week 7, participants underwent eight discussion and hands-on activities, including building advertising awareness, analyzing persuasion techniques in marketing and advertising, evaluating SSB advertising, and designing counter advertising messages, which is a form of media production. The IVR call in week 7-8 then reminded participants of the media analysis and production activities they received in class and asked them to be mindful of their drink choices.

MoveMore content

On the other hand, MoveMore participants were prompted in week 6's IVR call to think about how media push new exercise techniques or machines that show little effectiveness, pay attention to exercise equipment commercials, and keep track of them. In week 7, participants underwent two advertising discussions, including evaluation of claims in exercise gadgets, and detecting hidden messages in physical activity related media messages. The IVR call in week 7-8 reminded participants of the media analysis activities they received in class and asked them to watch for the claims in exercise gadgets.

These in-person sessions were taught by researchers specializing in health communication, nutrition and exercise. See Table 2 for a summary of corresponding components in SIPsmartER and MoveMore content.

Data collection

Trained research staff collected all data following a standardized protocol. Participants received gift cards in the amount of $25 and $50 for completing baseline and 6-month assessments.

MEASURES

Health literacy (Newest Vital Sign)

Health literacy was assessed using the validated 6-item Newest Vital Sign (NVS) (Weiss et al., 2005). NVS is an instrument that requires sufficient analytical and conceptual skills to interpret nutrition content using an ice cream label. This instrument requires participants to use both literacy and numeracy skills, which are essential for individuals to navigate health information (Weiss et al., 2005). Participants used a nutrition label to answer six questions based on the label, such as "If you are allowed to eat 60 grams of carbohydrates as a

snack, how much ice cream could you have?" Research staff administered this instrument orally to participants who also had scratch paper to do any calculations. Following validated procedures, participant's scores can range from 0 to 6 and are categorized as high likelihood of limited health literacy (scores 0-1), possibility of limited health literacy (scores 2-3), and adequate health literacy (scores 4-6) (Weiss et al., 2005). Conventionally, participants are further collapsed into two groups based on their scores: low health literacy (scores 0-3) and adequate/high literacy (scores 4-6).

Table 2. *Media Literacy Activities in SIPsmartER and MoveMore small group session*

Condition	Activity	Authors and audiences	Messages and meanings	Representation and reality
SIP*smart*ER [a]	*IVR Call #3* • Message about how companies use persuasive techniques using advertising to persuade us to buy their products		X	
	90 minutes of media literacy education in 1 lesson • Presentation about the purpose of marketing and advertising for sugary drink companies	X		
	• Use existing sugary drink advertising to discuss larger persuasive approaches (e.g., slogans, jingles, and images) as well as seven persuasive techniques (i.e., 4Ps in marketing, association, bribery, celebrities, color, humor, testimonials, & tricks)		X	
	• Critique print, radio, and television ads for sugary drinks and identify target audience, techniques, and what is missing	X	X	X
	• Modify slogans and create counter ads to make more "real" sugary drink ads		X	X
	IVR Call #4 • Message highlighting key points from lesson	X	X	X
MoveMore [a]	*IVR#3* • Message about there being a lot of "gimmicky" physical activity products that promise fast results with minimal efforts		X	X
	30 minutes of media literacy education in 1 lesson • Compare weight loss products to exercise recommendations. Discuss how most exercise products do not help customer meet exercise recommendations but their ads claim great effects.			X
	IVR#4 • Message highlighting key points from lesson			X

[a] Participants in each condition also received two IVR calls in week 5 (IVR#3) and week 7-8 (IVR#4). Both calls covered key theoretical constructs, including planned behavioral control, intentions, and media literacy. Both IVR messages asked participants in each condition to re-evaluate their personal action plan and provided support message relevant to their condition. Detailed content descriptions can be found in-text.

SSB Media literacy (SSB-ML)

The validated SSB-ML scale consisted of 18 questions on a 7-point Likert scale, with 1 being "strongly disagree" and 7 being "strong agree" (Chen et al., 2016). It was adapted from an antismoking media literacy scale (Primack et al., 2006; Primack & Hobbs, 2009; Primack et al., 2009) and focused on SSB advertising in three domains: Authors and Audiences (AA), Messages and Meanings (MM), and Representation and Reality (RR).

Authors and Audiences (AA) is measured by five questions asking participants to assess how SSB authors target specific audiences for profits. Messages and Meanings (MM) is measured by eight questions asking participants to assess how SSB messages contain values, points of views, and use multiple production techniques. Finally, Representation and Reality (RR) is measured by

six questions asking participants to assess the extent to which SSB messages omit health and nutrition information.

Reliability scores for all the domains were satisfactory (.64-.82 in pretest domains and .68-.82 in posttest domains). In addition to these three domains, we also averaged the scale by combining all of the domains together to form an overall media literacy scale. A complete list of media literacy domains, questions, and reliability scores can be found in Table 3.

Table 3. *Questions in and reliability of the SSB Media Literacy Scale (SSB-ML) and its three domains*

Media literacy questions	Domains	Cronbach's α [a]
1. Grocery store or convenience store deals on sugary drinks, like buy-one-get-one free and other sales, are designed to get people addicted to sugar 2. Sugary drink companies are very powerful, even outside of the beverage business 3. Sugary drink companies only care about making money 4. Certain sugary drink brands are designed to appeal to people like me 5. When designing an ad campaign, sugary drink companies think very carefully about the people they want to buy their beverages	Authors and Audiences (AA): Profit and target	$AA_{baseline} = .64$ $AA_{6-months} = .68$
6. Wearing a shirt with a sugary drink logo on it makes you a walking advertisement 7. Sugary drink ads link drinking these beverages to things people want, like love, good looks, and power 8. Two people may see the same movie or TV show and get very different ideas about it. 9. Different people can see the same sugary drink ad in a magazine and feel completely different about it. 10. A sugary drink ad may catch one person's attention but not even be noticed by another person. 11. People are influenced by TV and movies, whether they realize it or not. 12. People are influenced by advertising. 13. When people make movies and TV shows, every camera shot is very carefully planned. 14. There are hidden messages in sugary drink ads.	Messages and Meanings (MM): Values, interpret, attitudes, techniques	$MM_{baseline} = .79$ $MM_{6-months} = .82$
15. Most movies and TV shows that show people drinking sugary drinks make it look more attractive than it really is. 16. Sugary drink ads show a healthy lifestyle to make people forget about the health risks, such as weight gain and diabetes. 17. When you see a buy-one-get-one-free or other type of sugary drink sale, it's usually not actually a good deal in the long run. 18. When you see a sugary drink ad, it is very important to think about what was left out of the ad. 19. Advertisements usually leave out a lot of important information.	Representation and Reality (RR): Filter and omit	$RR_{baseline} = .82$ $RR_{6-months} = .80$
OVERALL SSB-ML		**.89**

[a] Original data were used to calculate reliability scores in keeping with Chen et al. (2016).

Data analysis

Data were entered into SPSS statistical analyses software (version 21, 2012, International Business Machines Corporation, Pittsburgh, PA).

To summarize baseline demographic characteristics (Table 1), descriptive statistics were used. Chi-square tests of association were used to compare demographics between conditions.

Multilevel mixed-effects linear regression and moderation analysis were performed to test the two proposed hypotheses using Stata software to account for clustering of individuals within eight-county cohorts (version 15, 2018, Stata Corp LP, College Station, TX). The analyses are based on the intention-to-treat using last-observation-carried-forward method. Data points that lacked the 'last-observation-carried-forward' value (e.g., incomplete data at the individual item level at baseline) were treated as missing.

After compiling the 'last-observation-carried-forward' values, scales were then calculated using validated procedures (Chen et al., 2016; Weiss et al.,

2005). Therefore, the total number of participants retained in the analyses (n = 272 vs. 301 in the original dataset) reflected the available data points using the last-observation-carried-forward approach.

Hypothesis 1 was tested using the mixed-effect models for the SSB-ML scale and three domains controlled for individual baseline characteristics, time-dummy (baseline vs. 6 months), condition-dummy (SIP*smart*ER vs. MoveMore), and a two-way interaction terms (time x condition). All models calculated county/cohort cluster-robust standard errors.

Baseline covariates controlled in the models included age, gender, race/ethnicity, income, disability status, marital status, education level, NVS total continuous health literacy score, employment status, number of children, smoking status, and Body Mass Index (BMI).

The exploratory hypothesis 2 investigated the potential for health literacy to moderate intervention effects on media literacy scales and domains. Hypothesis 2 also controlled for the same baseline covariates as Hypothesis 1.

To test hypothesis 2, a dummy variable based on the standardized scoring for NVS was created (i.e., the health literacy status dummy =0 if NVS score is 0-3 [i.e., low health literacy]; the health literacy status dummy =1

if NVS score is 4-6 [i.e., high health literacy]). Then hypothesis 2 was tested using mixed-effect models with added two- (time x condition; time x health literacy dummy; condition x health literacy dummy) and three-way (time x condition x health literacy dummy) interactions terms for the SSB-ML scale and three domains.

The coefficient of the three-way interaction indicates the moderation effect of health literacy dummy on the relative treatment effects between SIP*smart*ER and MoveMore conditions from baseline to 6-month.

RESULTS

H1: Impact of intervention on SSB Media Literacy skillsets and domains

Hypothesis 1 postulated that intervention participants (SIP*Smart*ER) would have greater increases in SSB media literacy skills across all media literacy domains than MoveMore participants.

The relative difference in the overall SSB-ML scale between SIP*smart*ER and MoveMore over a 6-month period was .23 (95 % CI = 0.126, 0.341, $p < 0.001$) (See Table 4).

Table 4. *Changes in Self-Reported SSB Media Literacy Scale (SSB-ML) by treatment condition (N = 272 [a])*

Variable	SIP*smart*ER (*n*=136) [a]			Move More (*n*=136) [a]			Relative effects between conditions [c]
	Base-line [b]	6 month [b]	Adjusted change baseline to 6 month [c]	Base-line [b]	6 month [b]	Adjusted change baseline to 6 month [c]	
	Mean (SD)	*Mean (SD)*		*Mean (SD)*	*Mean (SD)*		
Overall SSB-ML	*5.90* *(.85)*	*6.28* *(.82)*	.38 (95% CI = .310,.446)***	*5.99* *(.62)*	*6.13* *(.58)*	.14 (95 % CI = .087,.203)***	.23 (95 % CI =.126,.341)***
Authors and audiences (AA)	*5.66* *(1.04)*	*6.06* *(1.03)*	.40 (95% CI =.258,.539)***	*5.72* *(.85)*	*5.86* *(.85)*	.15 (95 % CI =.052,.245)**	.25 (95 % CI = .066,.434)**
Messages and meanings (MM)	*6.13* *(.77)*	*6.42* *(.73)*	.28 (95% CI =.210,.354)***	*6.22* *(.60)*	*6.33* *(.54)*	.12 (95 % CI =.065,.171)***	16 (95 % CI = 072,.257)***
Representation and reality (MM)	*5.71* *(1.21)*	*6.24* *(1.10)*	.53 (95% CI =.443,.618)***	*5.86* *(.87)*	*6.04* *(.77)*	.19 (95 % CI =.083,.300)***	.34 (95 % CI = 192,.491)***

Within condition and between condition statistical significance indicated by asterisks: **$p < .01$; ***$p<.001$

[a] The total number in both condition reflects the available data based on the intention-to-treat analysis results.

[b] Means (Standard Deviations) are not adjusted for covariates.

[c] Models controlled for baseline covariates including age, gender, race/ethnicity, income, disability status, marital status, education level, health literacy, employment status, number of children, smoking status, and BMI. The 95 % confidence intervals are also adjusted to be cohort robust. Analytic procedures used intention-to-treat last observation carried forward imputations.

More specifically, the within condition effect for improvements in SSB-ML for SIP*smart*ER was greater (.38, 95 % CI = 0.310, 0.446, $p < 0.001$) relative to the within condition effect for MoveMore (.14, 95 % CI = 0.087, 0.203, $p < 0.001$). Likewise, the relative differences between SIP*Smart*ER and MoveMore over a 6-month period for AA, MM, and RR were .25 (95 % CI = 0.066, 0.434, $p < .01$), .16 (95 % CI = 0.072, 0.257, $p < .001$), and .34 (95 % CI = 0.192, 0.491, $p < .001$), respectively. It should be noted that within the MoveMore condition, participants also significantly increased their SSB media literacy skills between baseline and 6-month (.14 for SSB-ML, 95 % CI = 0.087, 0.203, $p < .001$; .15 for AA, 95 % CI = 0.052, 0.245, $p < .01$; .12 for MM, 95 % CI = 0.06, 0.17, $p < .001$; .19 for RR, 95 % CI = 0.083, 0.296, $p < .001$). Yet, the relative differences between condition effects described above still illustrate SIP*smart*ER participants' greater changes in outcomes. Therefore, hypothesis 1 was supported.

H2: Impact of intervention and health literacy on Media Literacy skillsets

The exploratory hypothesis 2 predicted that low health literacy participants would increase their media literacy skillsets significantly more than high health literacy counterparts. Results showed that holding everything constant, SIP*smart*ER's treatment effect on the overall media literacy scale *and* its domains was not moderated by participants' health literacy level.

These null findings were a result of both low and high health literacy participants within each condition improved their SSB-ML and three domains. Using the SSB-ML scale as an example, low health literate SIP*smart*ER participants improved .35 (95 % CI = 0.198, 0.510, $p < 0.001$), high health literate SIP*smart*ER participants improved .39 (95 % CI = 0.319, 0.466, $p < 0.001$), low health literate MoveMore participants improved .16 (95 % CI = 0.016, 0.304, $p < 0.05$) and high health literate MoveMore participants improved .14 (95 % CI = 0.033, 0.244, $p = .01$) between baseline and 6-month.

The same patterns were observed in the remaining outcomes, demonstrating that this media literacy intervention benefited the adult participants, regardless of their health literacy level. The exploratory hypothesis 2 was not supported.

Discussion

This secondary data analysis is one of the first to provide direct evidence on how adults responded to media literacy education. Our findings are noteworthy as the media literacy training is one of the key components that significantly reduced adults' SSB consumption in the primary Talking Health trial (Zoellner et al., 2014). While in this study, we could not isolate media literacy's unique contribution to the behavioral outcome. Our secondary data analysis focused on changes in media literacy skillsets between conditions. Specifically, SIP*smart*ER effectively increased SSB-related media literacy skills between baseline and 6-month follow-up, compared to the *matched-contact comparison* condition (MoveMore).

Indeed, the training touched on a skill that adults rarely get to practice and develop. Specific improvements included critically examining media producers' purposes of designing persuasive messages, the persuasion techniques and viewpoints in each food commercial, and the omission of scientific facts in SSB advertising. The significant differences between conditions are crucial as the intensity of the contact time, matching content with a specific behavioral target, and a comprehensive coverage of all domains *mattered*. This is especially important as the ability to contrast media representation and omission (i.e., representation and reality) would have much more depth if participants possess an ability to identify media producers' intentions and decipher persuasion attempts in prior domains (Primack & Hobbs, 2009).

Given that adults' perceptions of sugary beverages determine what they and their family consume (Bogart et al., 2013; Hennessy et al., 2015), these collective results suggest a need to involve adults more broadly in future media literacy education. This study also contributes to the evidence that affirms adults' capacity to cultivate media awareness and critical thinking skills (Hindin et al., 2004; Scull & Kupersmidt, 2010). This one-session approach to media literacy education has the potential for adoption to intervention settings where time and resources are limited. Further, the use of the longitudinal (baseline, lesson in week 7 and 6-month follow-up) and randomized controlled trial design adds rigor to assessments of media literacy interventions and fills an important gap in the literature.

An interesting finding not explored in the original hypothesis is the increase in SSB-ML scores within the MoveMore participants — who only critiqued exercise gadget commercials and spent considerably less time on media literacy activities (30 minutes vs. 90 minutes in SIP*smart*ER). In other words, less intense media literacy education activities may have positive impacts on adults' perceptions of advertising across contexts.

These findings are likely the result of closely matching intervention content with theoretical domains. MoveMore activities primarily centered on representation and reality that epitomizes the highest progression in the theoretical domains. It is also a crucial behavioral intervention modifier for populations that have a direct experience with the targeted behavior (e.g., those who consume a large quantity of SSBs) (Chen et al., 2016; Primack & Hobbs, 2009; Primack et al., 2009). Activities focusing on representation and reality, therefore, may have raised MoveMore participants' cross-context awareness since they also have a direct experience with the behavior (i.e., consumed more than 200 Kcals/day in SSB — an eligibility criterion). Incorporating a physical activity media literacy scale could add clarity to interpretations. The nature of secondary data analysis, however, limits the possibility. Future research should explore whether transferring across behaviors works in other behavioral contexts, adding comparable media literacy scales vis-à-vis conditions to compare within and between improvements, and whether variations in domain emphasis (i.e., emphasizing one domain at a time, using a combination of the domains, etc.) for populations with or without a direct behavioral experience would arrive at the same conclusion.

This study also answered the call from Carbone and Zoellner (2012) to explore the potential moderating effect of health literacy. Contrary to the assumption that low health literacy adults may improve significantly more, both literacy groups improved at the end of their 6-month follow-up. The improvement from high health literacy adults is noteworthy.

One would assume that health literate adults may already be media literate and have no need for such intervention. This study, however, suggests that high health literate individuals still had room to deepen their media management skills. A recent study on health literacy and the use of persuasive techniques in media counter-ad production also came to a similar conclusion (Porter et al., 2018), corroborating that a skillset in health literacy does not necessarily translate to adults' ability to "read" and "talk back to" the media. Further,

this finding supports the primary outcome paper for Talking Health that found health literacy did not influence retention, engagement, or the primary SSB outcome (Zoellner et al., 2014). Taken together, media literacy education is crucial, regardless of adults' health literacy status. Focused efforts and application of health literacy strategies in program planning and implementation can result in similar benefits among low and high health literate participants.

Limitations

Some limitations in this study warrant careful interpretations of our results. This secondary data analysis was confined by the existing randomized controlled trial design. Adding a control group that has no media literacy contact and/or adding a physical activity media literacy scale could further tease out the significant within condition effects (i.e., why MoveMore participants also increased SSB-ML scores). Second, this secondary data analysis was not specifically powered to detect health literacy moderation effects. The null findings should be interpreted somewhat cautiously as lack of statistical power may be an issue. Nonetheless, our study provides key information needed to inform future media and health literacy studies.

CONCLUSIONS

Media literacy education improved adults' SSB media literacy skillsets. SIP*smart*ER participants had the largest improvements, compared to their MoveMore counterparts. They increased their ability to question SSB advertisers' motives, examine various viewpoints, and critique the representative nature of SSB messages while identifying missing health information. The intensity and comprehensiveness of the educational content as well as matching content with a specific behavioral target *matter*.

This study also found that both high and low health literate adult participants improved their media literacy skillsets, suggesting that health literacy is not a significant moderator and that media literacy education is crucial for adults of *all* health literacy levels. Understanding how variations in theoretical domains as reflected in content design and the potential moderating role of health literacy in other behavioral contexts would advance nutrition-based media literacy education so adults can outsmart media.

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