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Automatic associations of breast cancer and heart disease with fruit and vegetables and physical activity

Tanya R Berry[1], Kerry S Courneya[1], Colleen M Norris[2], Wendy M Rodgers[1] and John C Spence[1]

Abstract

Objectives: This exploratory research examined if breast cancer or heart disease is automatically associated with physical activity compared to fruit and vegetable stimuli; if reading messages about reducing risk of breast cancer or heart disease through physical activity and fruit and vegetable consumption would affect automatic associations; and if automatic associations were related to intentions to be physically active or consume fruit and vegetables.

Methods: Participants were 80 women who completed pretest measures of automatic associations, then read a breast cancer, heart disease, or control message, followed by posttest measures.

Results: There was a significant association of breast cancer–related words with fruit and vegetables compared to physical activity. Heart disease was also more strongly associated with fruit and vegetables than physical activity at pretest but not at posttest. There were no other significant findings.

Conclusion: This research highlights that fruit and vegetables rather than physical activity are more strongly associated with perceptions of breast cancer and heart disease. Automatic associations are an attitudinal construct, and the strength of association between fruit and vegetables, rather than physical activity, indicates how messages may be processed.

Keywords

Breast cancer, heart disease, prevention, automatic associations, physical activity, diet

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Introduction

Public health agencies advocate for behaviors such as physical activity and consuming fruit and vegetables in order to reduce risk of diseases such as breast cancer and heart disease.[1,2] Messages highlighting these behaviors could act as health-related cues and activate automatic associations related to the message topics.[3] Automatically activated associations reflect the associations one holds in long-term memory that are strengthened with repeated exposures.[4] According to the associative–propositional evaluation (APE) model,[4] multiple associations related to the same topic can exist, which associations are activated is based on the already existing memory structures and the specific cue or context present at activation. For example, if heart disease prevention is associated with both physical activity and fruit and vegetable consumption, the association that is more strongly held should be activated first by a prevention message that discusses both behaviors.

There is much more media coverage about breast cancer than heart disease, and women report seeing more information about breast cancer than heart disease in the media.[5] Furthermore, women who reported eating more fruit and vegetables had lower perceived susceptibility to heart disease relative to breast cancer, but physical activity was not associated with risk perceptions of either disease.[5] It has also been reported that diet is more prevalent than exercise in media coverage of cancer; that diet is discussed more as a preventive measure of cancer; and the more people report

[1]Faculty of Kinesiology, Sport, and Recreation, University of Alberta, Edmonton, AB, Canada
[2]Faculty of Nursing, University of Alberta, Edmonton, AB, Canada

Corresponding author:
Tanya R Berry, Faculty of Kinesiology, Sport, and Recreation, University of Alberta, 1-153 University Hall, Edmonton, AB T6G 2H9, Canada.
Email: Tanya.berry@ualberta.ca

paying attention to health news, the greater their knowledge of diet, but not exercise, as related to cancer risk.[6] This indicates that different prevention behaviors (e.g. fruit and vegetable consumption and physical activity) may differ in how strongly they are associated with the diseases; it is likely that fruit and vegetables will have stronger associations compared to physical activity.

It is possible that the associations activated by reading prevention messages will be related to the strength of intention to pursue that behavior. Although, holding an intention does not necessarily lead to behavior, there is nonetheless a strong relationship between intention and behavior.[7] Therefore, if automatically activated associations are related to intention, this could point to an intervention target. For example, training interventions could be created to strengthen associations so that an intention can be formed;[3] that is, automatically activated associations may influence the commitment to pursue an action.[7] A decision to be physically active could occur if an underlying commitment to do so is triggered by the automatic activation of a physical activity association. However, this is highly speculative and research is needed to determine what associations exist for breast cancer and heart disease and if they are activated by prevention messages. Thus, the research presented here is exploratory and is conducted as a first step for future research. As Sakaluk[8] puts it, this study is one designed to "explore small," in an effort to determine "to what extent something exists, and under what conditions" (p. 48).

Of course, there are other factors related to intentions to pursue prevention behaviors. In the context of this article, it was also deemed important to consider whether disease-related perceptions, such as fear of the diseases and perceptions of ability to reduce risk of the diseases, were related to intentions to be physically active or to consume fruit and vegetables. Previous research has shown that women perceive greater risk from breast cancer than heart disease, fear breast cancer more, but feel they have more control over heart disease than breast cancer.[9] Thus, disease perceptions may play a role in intention to engage in prevention behaviors, and should be controlled for when examining the effects of reading prevention messages on automatic associations and intention. Similarly, attitudes toward the behavior and previous behavior are strongly related to intention and should also be considered.[7]

There are three main aims of this study: (1) to examine if breast cancer or heart disease was automatically associated with physical activity or fruit and vegetable stimuli, (2) to determine if reading messages about reducing risk of breast cancer or heart disease through physical activity and fruit and vegetable consumption would affect automatic associations, and (3) to determine if automatic associations were related to intentions to be physically active or to consume fruit and vegetables.

It is hypothesized that (1) there will be stronger automatic associations of heart disease and breast cancer with fruit and vegetables relative to physical activity; (2) reading the messages will activate the association with fruit and vegetables relative to physical activity; and (3) automatic associations of disease with fruit and vegetable consumption will be related to higher fruit and vegetable intention and that automatic associations of disease with physical activity will be related to physical activity intention.

Methods

Participants

Women ($N = 89$) were recruited from community populations using posters, advertisements, or email list-serves for a study about "perceptions of health risk" without specifying breast cancer or heart disease. A power analysis using G*Power 3.1.9.2[10] for a repeated measures (RM) analysis of variance (ANOVA) within–between interaction, alpha = .05, power = 80, a medium effect size, three groups and two measures, and a correlation between RM of .3 yielded a sample size of 60. A power analysis for a linear multiple regression with R^2 increase with the same alpha, power, and effect sizes, and 12 predictors yielded a sample size of 85.

Procedures

Procedures for this experimental study were approved by a University Human Research Ethics Board, and informed consent was provided before participation. A random number generator assigned participants to breast cancer, heart disease, or control message conditions. Automatic associations between breast cancer or heart disease and physical activity and fruit and vegetable consumption were measured at pretest using a Go/No Go association task (GNAT). Participants then read their assigned message, followed by posttest measures: thought listing (manipulation check), the GNAT again, and a questionnaire of message strength and believability, attitudes and intentions regarding fruit and vegetable consumption and physical activity, fear of the diseases, perceptions of the ability to reduce risk of the diseases, and demographics.

Messages

The messages were based on information from the Heart and Stroke Foundation of Canada (heart disease condition), the Canadian Cancer Society (breast cancer condition), and a magazine article about decluttering your home (control condition). The disease messages were about 450 words with a reading grade level of 8.9 and gave information about the relationships between physical activity and fruit and vegetable consumption and disease risk (e.g. from the heart disease message: "Another benefit of physical activity is that it can lower your risk of developing heart disease by 30%"). This was followed by the recommended guidelines of 150 min of

moderate-to-vigorous physical activity per week in bouts of 10 min or more, seven or more servings of fruits and vegetables per day, and tips on how to increase physical activity and fruit and vegetable consumption. The control message was 351 words and had a reading grade level of 8.0. It started with benefits of declutter (e.g. "A benefit of decluttering is that your home will become a relaxing place that you will want to spend time in") followed by decluttering tips.

Implicit measure

GNAT. The GNAT is an indirect measure of automatic associations which has been shown to have good convergent and discriminant validity.[11,12] This task measured the automatic associations between breast cancer or heart disease and physical activity and fruit and vegetables. Participants categorized words that belong to a target category by hitting the space bar (go) as fast as they could, or did not hit the space bar if the word did not belong to the category (no go). For example, in a given block of trials, a participant was told the categories were heart disease and physical activity and if she saw a word from either category, she was to choose "go." If she saw a breast cancer–related word or fruit and vegetable–related word, she was to choose "not to go." The response deadline was 850 ms. The decisions to use this response deadline and response time (RT) as the measure of automatic associations were made because of the age range of participants. RT decreases and intrasubject variability increases with age, particularly in women,[13] making it difficult to determine the appropriate response deadline to measure sensitivity (i.e. categorization errors, the other possible outcome measure from a GNAT). A red "X" for an error or a blue "O" for a correct response was shown after each trial. The block order was counterbalanced so that some participants categorized heart disease and physical activity words first, others breast cancer and fruit and vegetables first, and so on. The breast cancer–related words were chemotherapy, breast surgery, breast cancer, mastectomy, carcinoma, malignant, tumor, and metastasize. The heart disease–related words were angioplasty, heart surgery, transplant, cardiovascular, stroke, cardiac, coronary, and angina. The physical activity–related words were walking, swimming, hiking, strength training, biking, stair climbing, stretching, and jogging. The fruit and vegetable–related words were carrots, leafy greens, bell peppers, apples, bananas, oranges, tomatoes, and sweet potatoes.

Explicit measures

All survey items are shown in the Supplementary file.

Thought listing (reading manipulation check). Participants listed up to five thoughts they had while reading the messages.

Message strength, believability, and attention (message manipulation check). Message strength was assessed with eight semantic differential items (e.g. unimportant/important, irrelevant/relevant, and uninteresting/interesting) rated from 1 to 7. These items showed good validity by Zaichkowsky.[14] The internal reliability in this study was good for the measure of message strength, Cronbach's $\alpha = .89$, and the mean score was used. Message believability was assessed with eight items rated from 1 to 7, validated by Beltramini[15] (e.g. not believable/believable, unconvincing/convincing, and unquestionable/questionable). The internal reliability in this study was good, Cronbach's $\alpha = .95$, and the mean score was used. Four items, validated by Laczniak et al.,[16] assessed attention, concentration, involvement, and amount of thought given to the messages rated from 1 to 7. Internal reliability in this study was good, Cronbach's $\alpha = .85$; a mean score was used to assess attention paid to the messages.

Affective attitudes. The statements "Being physically active for at least 150 minutes a week" and "Eating seven or more servings of fruits and vegetables every day" were rated on two semantic differential items (unpleasant/pleasant and unenjoyable/enjoyable) rated from 1 to 7, as recommended by Rhodes et al.[17] Correlations between items were strong for both physical activity attitude, $r = .71$, and attitude toward fruit and vegetable consumption, $r = .75$.

Intention. The statements "I intend to be physically active for at least 150 minutes a week" and "I intend to eat seven or more servings of fruits and vegetables every day for the next week" were each rated from 1 (extremely unlikely) to 7 (extremely likely), as recommended by Rhodes et al.[17]

Disease perceptions. Single items from previous research[18] measured fear and risk reduction beliefs relative to breast cancer and heart disease. The items were "the thought of breast cancer/heart disease scares me" (from 1 (strongly disagree) to 7 (strongly agree)), and "how much a person can do to reduce risk of getting breast cancer/heart disease" (from 1 (nothing) to 5 (completely eliminate risk)).

Health behaviors. Participants indicated if they were a current smoker, ex-smoker, or had never smoked. Leisure-time physical activity was ranked as very light (almost none), light (walking or nonstrenuous cycling or gardening once a week), moderate (regular activity at least once a week), active (regular activities such as intense walking more than once a week), or very active (strenuous activities several times a week). This item has been validated using doubly labeled water for measurement of physical activity.[19] Participants also reported the likelihood, in terms of percentage, whether they regularly consume the recommended daily number of fruits and vegetables over a month.

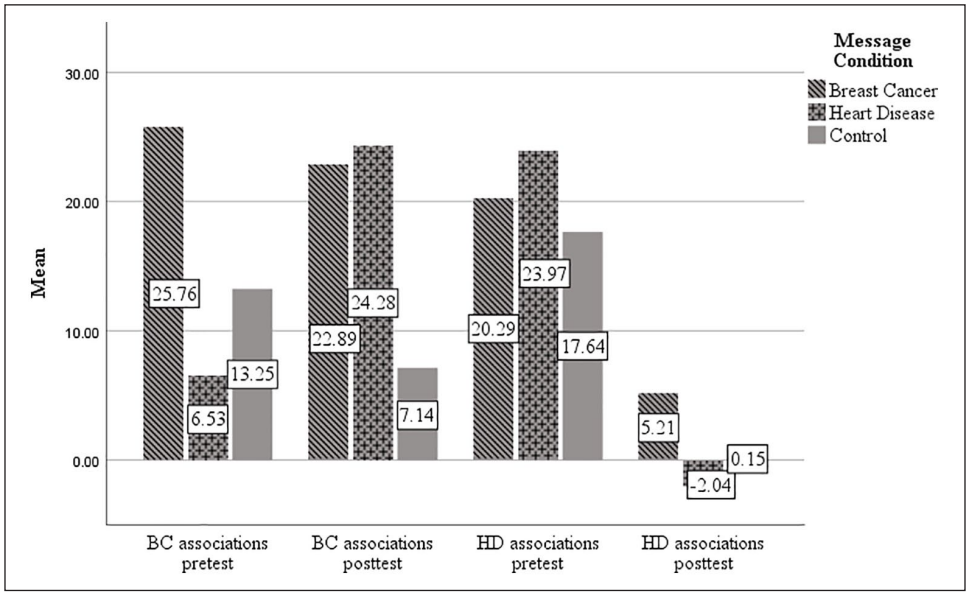

Figure 1. Heart disease and breast cancer automatic associations with fruit and vegetables compared to physical activity, by message condition, at pretest and posttest. A positive score indicates a stronger association with fruit and vegetables than physical activity.

Demographics. Participants self-reported their height and weight—which was used to calculate body mass index (BMI), age in years, highest level of education (high school, some college, college or technical school diploma, bachelor's degree, post-graduate, or professional degree), marital status (single, married, divorced or separated, widowed), ethnicity (open-ended), and annual household income in increments of US$20,000 starting at under US$20,000 to more than US$100,000. Participants were also asked if a doctor or nurse had ever told them they had (yes/no) high blood pressure, high cholesterol, heart disease, stroke, angina, diabetes, cancer (and if yes, what type), or any other long-term health condition.

Data analysis

Preliminary analyses used chi-square and ANOVA tests to examine differences between conditions on demographic variables and message strength, believability and attention. Differences between fear or ability to reduce risk of breast cancer relative to heart disease were measured with two RM ANOVAs with fear of breast cancer and heart disease and ability to reduce risk of the breast cancer and heart disease as the within-subjects variables and message condition as the between-subjects variable.

GNAT data were screened for errors and RTs faster than 250 ms. Breast cancer and heart disease automatic association scores can be seen from Figure 1 and regression models. The scores are the difference between RTs when breast cancer or heart disease was paired with fruit and vegetables as "go" words compared to when breast cancer or heart disease and physical activity were "go" words. A positive score indicates a stronger automatic association of the disease words with fruit and vegetables compared to physical activity.

To test the first hypothesis (that there would be stronger automatic associations of breast cancer and heart disease with fruit and vegetables relative to physical activity), two RM ANOVAs with message condition as the between-subjects factor compared: (1) RTs when breast cancer and physical activity were "go" trials to when breast cancer and fruit and vegetables were "go" trials across time (within-subjects; pretest, posttest) and (2) RTs when heart disease and physical activity were "go" trials to when heart disease and fruit and vegetable were "go" trials across time. These analyses were also used to test the second hypothesis (that reading the breast cancer and heart disease messages would activate stronger fruit and vegetable associations relative to physical activity because of pre-existing associative pathways). A post hoc power analysis for an RM ANOVA within–between interaction, with alpha = .05, sample size = 80, three groups and two measures, and a correlation between RM of .3, yielded a critical $F = 3.12$ and power = .92.

The third hypothesis was tested using regression analyses to determine if intentions to be active or to consume the recommended amounts of fruit and vegetables were related to automatic associations, explicit attitudes, or behavior, while controlling for demographic or disease perception variables. The inclusion of possible covariates was determined using correlations. All variables were mean-centered prior to entry into the models. A post hoc power analysis on a fixed model, with R^2 increase, alpha = .05, sample size = 80, and total number of predictors = 11, yielded a critical $F = 2.51$ and power = .77.

Table 1. Response time mean values and standard deviations in milliseconds for automatic associations at pretest and posttest and post hoc test of change from pretest to posttest.

Associations	Pretest	Posttest	RM ANOVA
Heart disease and physical activity	598.83 (42.17)	585.68 (45.04)	$F(1, 77) = 5.88$, $p = .02$, $d = 0.30$
Heart disease and fruit and vegetables	578.04 (40.36)	584.52 (44.60)	$F(1, 77) = 2.10$, $p = .15$, $d = 0.15$
Breast cancer and physical activity	601.73 (36.94)	599.11 (41.15)	$F(1, 77) = 0.54$, $p = .46$, $d = 0.07$
Breast cancer and fruit and vegetables	586.45 (48.51)	580.45 (46.74)	$F(1, 77) = 1.64$, $p = .20$, $d = 0.13$

RM ANOVA: repeated measures analysis of variance.

Results

Preliminary analyses

One participant reported having diabetes and high blood pressure, both significant contributors to cardiovascular disease, and her data were excluded. The data from four other participants were also excluded because they made errors on more than 25% of the GNAT trials, and using RTs as the outcome variable in a GNAT requires accurate responding.[10] Two participants missed many questions on the questionnaires, and their data were also excluded. All the heart disease condition participants wrote something during the thought listing about fruit and vegetable consumption and/or physical activity and all control participants mentioned decluttering. Two breast cancer participants who did not mention either fruit and vegetable consumption or physical activity were also omitted leaving a final sample of 80 participants: with 28 in the breast cancer condition, 28 in the heart disease condition, and 24 in the control condition.

Participants' age ranged from 18 to 65 years ($M = 25.78$ ($SD = 8.13$)) with an average BMI of 22.99 ($SD = 4.88$; range = 16.39–43.85). In total, 24 participants had high school or some college education, 38 had a bachelor's degree, and 18 had a post-graduate or professional degree. The majority of the sample was single ($n = 66$; 82.5%). A total of 38 participants had family incomes of less than US$40,000/year, 21 had incomes between US$40,000 and US$80,000 and 20 had incomes of US$80,000 or more (one did not report). A total of 33 self-identified as Caucasian or White, 22 as Asian, 22 were from a variety of other ethnicities, and 3 did not report. A total of 16 participants reported very light or light activity, 33 reported moderate activity, and 31 reported being active or very active. The range of eating the recommended amounts of fruit and vegetables was from 0 to 100, $M = 65.93$ ($SD = 26.08$). One participant was a current smoker, 6 were ex-smokers, and 73 had never smoked. No differences existed between conditions on any demographic variables, all $p > .05$.

No significant differences existed in message attention, $F(2, 77) = 2.72$, $p = .08$, but there were significant differences in message believability, $F(2, 77) = 10.88$, $p < .001$, and message strength, $F(2, 77) = 4.76$, $p = .01$. Post hoc tests showed no differences between the heart disease and breast cancer conditions on any of these variables, all $p > .30$, but the heart disease and breast cancer messages were rated more believable and stronger than the control message, all $p < .02$.

There was a significant difference in fear of breast cancer compared to heart disease, $F(1, 79) = 12.93$, $p = .001$, Cohen's $d = 0.30$, but no difference by message condition, $F(2, 77) = 0.57$, $p = .57$. Participants feared breast cancer ($M = 5.82$, $SD = 1.42$) more than heart disease ($M = 5.35$, $SD = 1.74$). Significant differences existed in perceptions of ability to reduce risk of breast cancer compared to heart disease, $F(1, 77) = 64.64$, $p < .001$, Cohen's $d = 1.13$, but no difference by message condition, $F(2, 77) = 0.81$, $p = .45$. Participants had higher perceptions of their ability to reduce risk of heart disease ($M = 3.63$, $SD = 0.58$) compared to breast cancer ($M = 2.85$, $SD = 0.78$).

Automatic associations—hypotheses 1 and 2

Mean values and standard deviations for the associations between the diseases and the behaviors at pretest and posttest are shown in Table 1. The results of the RM ANOVA showed a main effect for breast cancer automatic associations, $F(1, 77) = 26.46$, $p < .001$, but no change over time, nor differences between message conditions or any interactions, all $p > .17$. As shown in Figure 1, breast cancer was more strongly associated with fruit and vegetables than physical activity at pretest, Cohen's $d = 0.35$, and at posttest, Cohen's $d = 0.42$, across all conditions. There was also a significant main effect for heart disease automatic associations, $F(1, 77) = 11.24$, $p = .001$, but no main effect of change over time, nor differences between message conditions, all $p > .34$. There was a significant time by association interaction, $F(1, 77) = 8.34$, $p = .005$. Follow-up analyses showed there were significantly stronger associations for heart disease with fruit and vegetables relative to physical activity, collapsed across message conditions, at pretest, $p < .001$, Cohen's $d = 0.50$, but not at posttest, $p = .80$, Cohen's $d = 0.03$. Another series of RM ANOVA tests were conducted to explore changes in associations between each disease and each behavior (e.g. associations between heart disease and physical activity) from pretest to posttest. Results are shown in Table 1. The only significant change was in associations between heart disease and physical activity, which were faster at posttest than at pretest.

Table 2. Correlations between physical activity, fruit and vegetable intentions and demographic variables, disease perceptions, and automatic associations.

S. no.		PA intention	FV intention	1	2	3	4	5	6	7	8	9	10	11
1	Age	.000	.128											
2	BMI	.040	.146	.356	–									
3	Education	.153	.162	.370	.163	–								
4	Income	.113	.039	.092	–.083	–.081	–							
5	BC fear	.074	.200	–.105	.064	–.107	–.057							
6	BC risk	–.097	.225	.139	.014	–.021	–.295	.028	–					
7	HD fear	–.064	.212	–.143	–.035	–.193	–.111	.740	.114	–				
8	HD risk	.089	.142	.205	.136	.149	–.075	.151	.205	.000	–			
9	BC associations pretest	–.015	–.055	–.110	.065	.128	.188	–.086	–.187	–.184	.104	–		
10	BC associations posttest	.190	.053	–.184	–.016	–.199	.258	.136	.079	.158	.050	.027	–	
11	HD associations pretest	–.169	–.044	.079	.208	.050	.121	–.273	.158	–.232	.138	.288	–.030	–
12	HD associations posttest	–.034	.115	–.143	.126	.007	–.080	.036	.014	.072	–.084	.145	.066	–.044

PA: physical activity; FV: fruit and vegetables; BMI: body mass index; BC: breast cancer; HD: heart disease.

Table 3. Summary of regression models predicting posttest intention and behavior.

Step	Model summary	Physical activity intention			Fruit and vegetable intention		
		$R^2\ \Delta = .054$, $F(4, 75) = 1.07$, $p = .38$			$R^2\ \Delta = .012$, $F(4, 75) = 0.22$, $p = .93$		
	Predictors	*B*	Std. error	Beta	*B*	Std. error	Beta
1	BC dummy	.294	.395	.101	.381	.528	.100
	HD dummy	–.227	.391	–.079	.313	.522	.083
	BC automatic associations pretest	<.001	.004	.003	–.002	.005	–.053
	HD automatic associations pretest	–.005	.004	–.162	–.002	.005	–.035
2	Model summary	$R^2\ \Delta = .342$, $F(4, 71) = 10.03$***			$R^2\ \Delta = .538$, $F(8, 67) = 10.01$***		
	BC dummy	.331	.332	.114	–.165	.390	–.043
	HD dummy	–.071	.331	–.025	.044	.388	.012
	BC automatic associations pretest	–.004	.003	–.108	–.002	.004	–.037
	HD automatic associations pretest	–.002	.004	–.064	–.002	.004	–.038
	BC automatic associations posttest	.004	.003	.108	.001	.004	.033
	HD automatic associations posttest	–.002	.003	–.045	.005	.004	.108
	Attitudes	.325	.103	.311**	.261	.147	.166
	Behavior	.585	.144	.410***	.042	.006	.609***
	BC fear	–	–	–	.039	.168	.030
	HD fear				.133	.135	.127
	BC risk reduction				.182	.215	.078
	HD risk reduction				.278	.281	.088

BC: breast cancer; HD: heart disease.
**$p < .01$; ***$p < .001$.

Relationship of constructs to intentions—hypothesis 3

Correlations between intentions and demographic variables, disease perceptions, and automatic associations are shown in Table 2. The variables included in the first step of the physical activity intentions model were the conditions (dummy coded) and pretest automatic associations; the variables included in the second step were attitudes, behavior, and posttest automatic associations. The fruit and vegetables intentions model was similar but also included the fear and perceptions of reduced risk variables in the second step because there were small correlations between these variables and fruit and vegetables intentions. Multicollinearity was assessed with tolerance scores and variance inflation factors (VIFs) and was not an issue in either model, all tolerance scores >0.39 and all VIF < 2.56. Results for the regression models are shown in Table 3. Physical activity attitudes and behavior were related to physical activity intentions, and fruit and vegetable behavior was related to intentions. There were no other significant predictors.

Discussion

The first purpose of this research was to investigate if breast cancer or heart disease was automatically associated with physical activity or fruit and vegetables. The related hypothesis, that automatic associations of heart disease and breast cancer would be stronger for fruit and vegetables relative to physical activity, was supported. A significant association of breast cancer with fruit and vegetables compared to physical activity was demonstrated at both time points. Heart disease was also more strongly associated with fruit and vegetables than physical activity at pretest. In general, these results indicate that there are likely stronger memory traces for fruit and vegetables compared to physical activity in relation to the diseases, particularly for breast cancer. As already noted, diet appears more often than physical activity in the media in relation to cancer prevention.[6] Thus, women may associate fruit and vegetables with breast cancer risk more strongly than physical activity because of repeated exposure.[4]

The second purpose was to see if reading messages about reducing risk of breast cancer or heart disease through physical activity and fruit and vegetable consumption would affect automatic associations. This hypothesis was not supported and there were no differences between conditions for any variables. However, there was a significant change over time, among all conditions, in heart disease associations. Whereas fruit and vegetables were more strongly associated with heart disease at pretest, this difference was no longer seen at posttest. A follow-up analysis indicated this may be due to a greater likelihood of heart disease and physical activity associations being activated at posttest, evidenced by faster RTs. The reasons for this finding are not obvious, but it may be a function of spreading activation, where activated associations spread to other related associations.[4] Heart disease prevention is likely strongly associated with both physical activity and a diet high in fruit and vegetables. The pretest may have resulted in participants considering the association between physical activity and heart disease, regardless of message condition. A person may be aware that an association has been activated, even if they cannot control the activation.[20] So, they may have considered the relationship of heart disease and physical activity as a result of the pretest measure of associations.

The third hypothesis was that automatic associations of disease with fruit and vegetable consumption would be related to higher fruit and vegetable intention and that automatic associations of disease with physical activity, would be related to physical activity intention. This hypothesis was not supported. Only attitude and regular behavior were related to either type of intentions. This is contrary to other works that showed women with stronger automatic belief that breast cancer is a risk for them had lower intention to be physically active.[18] Others found in a pulmonary rehabilitation setting that automatic associations of physical activity as positive, compared to sedentary behavior as positive, was related to physical activity behavior 6 months after the end of the rehabilitation program.[21] A study that examined automatic associations toward gay men or lesbians showed that participants who reported long-term friendships or acquaintances with people who were gay or lesbians showed more positive automatic associations with these groups and that positive associations were related to higher intention to vote in favor of gay rights.[22] It may be that positive affect toward physical activity or fruit and vegetables (i.e. liking them) are related to intentions, but by comparing them, their respective associations were lost. Future research should examine this possibility. It is also possible that affect is the strongest driver of physical activity behavior.[23]

One limitation of this research was that participants were likely already interested in health-promoting behaviors (indicated by their volunteering to do the study). Furthermore, though efforts were made to recruit a range of participants, women were on average younger and the majority were highly educated. This could influence the results, and this research should be replicated with a more diverse sample. This study is also partly observational and thus conclusions about causality cannot be reached. Future experimental work is needed to determine if and how automatic associations between disease and lifestyle-related stimuli influence intentions or behavior. This research provides a foundation for such work.

Conclusion

The American Cancer Guidelines highlight that both physical activity and consuming a diet that emphasizes plant-based foods are beneficial for reducing risk of breast cancer and heart disease.[1] Moderate physical activity is beneficial for breast cancer and heart disease. For example, women who walk at least 1 h per week were more likely to survive breast cancer than less active women.[24] It has also been shown that non-exercise physical activity is important for women's heart health.[25] Therefore, awareness of these behaviors is important and continued promotion is needed. Yet, this research highlights that fruit and vegetables rather than physical activity are more strongly associated with breast cancer and heart disease. Automatic associations are an attitudinal construct,[4] and the strength of association between fruit and vegetables, rather than physical activity, indicates how messages may be processed. If this research is successfully replicated, physical activity promoters may wish to create training interventions to strengthen associations of breast cancer and heart disease with physical activity.[3] Researchers may also investigate the context in which such associations are activated (e.g. by manipulating messages). Greater understanding of these issues may help create more effective health promotion messages.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

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Informed consent

Written informed consent was obtained from all subjects before the study.

ORCID iD

Tanya R Berry https://orcid.org/0000-0002-7062-587X

Supplemental material

Supplemental material for this article is available online.

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