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Self-affirmation alters the brain’s response to health messages and subsequent behavior change

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Health communications can be an effective way to increase positive health behaviors and decrease negative health behaviors; however, those at highest risk are often most defensive and least open to such messages. For example, increasing physical activity among sedentary individuals affects a wide range of important mental and physical health outcomes, but has proven a challenging task. Affirming core values (i.e., self-affirmation) before message exposure is a psychological technique that can increase the effectiveness of a wide range of interventions in health and other domains; however, the neural mechanisms of affirmation’s effects have not been studied. We used functional magnetic resonance imaging (fMRI) to examine neural processes associated with affirmation effects during exposure to potentially threatening health messages. We focused on an a priori defined region of interest (ROI) in ventromedial prefrontal cortex (VMPFC), a brain region selected for its association with self-related processing and positive valuation. Consistent with our hypotheses, those in the self-affirmation condition produced more activity in VMPFC during exposure to health messages and went on to increase their objectively measured activity levels more. These findings suggest that affirmation of core values may exert its effects by allowing at-risk individuals to see the self-relevance and value in otherwise-threatening messages.

Significance

Self-affirmation is a psychological technique that is effective in increasing receptivity to interventions across domains from promoting health behaviors in high-risk populations to improving academic performance in underrepresented groups. The neural mechanisms that lead to affirmation’s success, however, are not known. We show that neural responses associated with self-related processing and value in response to an otherwise-threatening health communication intervention can be changed using self-affirmation; furthermore, these neural responses predict objectively measured behavior change in the month following the intervention. These findings suggest that self-affirmation may exert its effects by allowing at-risk individuals to see the self-relevance and value in otherwise-threatening messages and provide a framework for studying neural effects of self-affirmation more broadly.
Potential Neural Mechanisms of Affirmation

The current investigation examines neural activity associated with the effects of self-affirmation on processing health risk messages related to sedentary behavior in sedentary adults. We focused on the brain’s ventromedial prefrontal cortex (VMPFC) during exposure to potentially threatening health messages emphasizing the need to be more active and less sedentary in a group of sedentary adults. VMPFC is the most common region implicated in self-related processing (51) and is also a key region, along with the ventral striatum, implicated in positive valuation of stimuli (52). In addition, VMPFC has been consistently associated with behavior change in response to health messages in prior work (44–46, 50). This prior research has suggested that the link between VMPFC activity during health message exposure and behavior change may stem from a recipient’s ability to process a health message as self-relevant or as having value to oneself. Thus, we hypothesized that if affirmation allows people to see otherwise-threatening information as more self-relevant and valuable, delivering self-affirmation before health messages should increase neural activity in VMPFC during message exposure. In addition, we hypothesized that internalizing the messages in this way would be associated with subsequent behavior change. More specifically, we hypothesized that increased neural responses within the VMPFC during message exposure would predict behavior change consistent with the messaging. In this case, we expected that increased activity in VMPFC in response to health messages should be associated with decreased sedentary behavior following the scan.

Results

Changes in Sedentary Behavior. We measured physical activity using wrist worn accelerometers (Methods and SI Methods). At baseline, participants were sedentary an average of 50.6% of their valid/awake time (SD, 14.0%; range, 21–84%), which is close to the national average (53). On average, controlling for baseline sedentary behavior and demographics, participants showed significant declines in their sedentary behavior over time in the month following exposure to the health message intervention ($t_{(34)} = −0.001; t = −3.49; P = 0.0005$).

Effects of Affirmation on Brain Activity and on Behavior Change. On average, participants who were affirmed showed greater activity during exposure to the health messages within our hypothesized VMPFC region of interest (ROI) compared with those who were unaffirmed, controlling for baseline sedentary behavior and demographics [$B = 0.15, t_{(34)} = 2.10, P = 0.04$; Fig. 1A]. For whole-brain effects of self-affirmation during exposure to health messages, see Table 1. We next examined the effect of self-affirmation on changes in sedentary behavior over time, controlling for baseline levels of sedentary behavior and demographics. Those who were in the affirmation condition decreased their sedentary behavior more over time following exposure to health messages (condition by time), compared with those in the control condition ($t_{(34)} = −0.002, t = −2.68, P = 0.008$; Fig. 1B).

Neural Activity During Health Messages Predicts Changes in Sedentary Behavior Distinct from Self-Reports. We next examined whether neural activity in our hypothesized VMPFC ROI during message encoding predicted changes in sedentary behavior over time following the scanner intervention. Those who showed greater activity in VMPFC during health message exposure also showed greater declines in sedentary behavior after the scan ($t_{(34)} = −0.006, t = −3.04, P = 0.002$; Fig. 2B). Finally, we examined whether the variance explained by neural activity overlapped with that explained by participants’ self-reports following the intervention. We observed significant relationships between self-reported standard measures and behavior change and between self-reported attitudes and behavior change (SI Results). To determine whether neural activity during health messages captures different information than that predicted by self-report measures, we next examined whether the relationships observed between affirmation condition and changes in sedentary behavior as well as neural activity in VMPFC during message exposure and behavior change held controlling for these measures (e.g., attitudes toward physical activity; self-standards as someone who can increase physical activity). All previously observed relationships between affirmation, neural activity, and behavior change remained significant when controlling for our attitude and self-standard measures. This suggests that the effects of affirmation and consequent neural activity in VMPFC during message exposure are explaining additional variance in the behavior change beyond those predicted by self-reports.

Discussion

Self-affirmation has been effective in augmenting interventions across a number of domains; however, the neural mechanisms supporting its effects have not been studied (29). We manipulated exposure to an MRI-compatible affirmation intervention before exposure to health risk messages in a group of sedentary adults (54). Our results demonstrated that participants who reflected on their highest value during the self-affirmation exercise...
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sedentary behavior more in the month following the scan, controlling for baseline sedentary behavior and demographics.

Fig. 2. but these results have been consistent behavior change up to 1 mo after message exposure, (45) and decrease smoking (46, 59) has predicted message-during exposure to messages designed to increase sunscreen use changing activity within VMPFC alters subsequent trajectories behavior change (e.g., refs. 42, 45, 46, and 59). The current study relationships between neural activity in VMPFC and health ways of successful affirmation with other successful methods for levels of analysis will allow more specific linkage of psychological mental of mappings between theory and evidence at different these mechanisms: e.g., refs. 34 and 56

information (although others have offered evidence concerning a threat (55), or why thinking about important values should worth in the face of new information that otherwise would pose in self-processing stem from maintaining prior levels of self-worth. They also do not address whether increases in self-processing stem from maintaining prior levels of self-worth in the face of new information that otherwise would pose a threat (55), or why thinking about important values should increase self-relevance and valuing of potentially threatening information (although others have offered evidence concerning these mechanisms: e.g., refs. 34 and 56–58). Further development of mappings between theory and evidence at different levels of analysis will allow more specific linkage of psychological and neural evidence.

More immediately, however, the neural results do link pathways of successful affirmation with other successful methods for health intervention. For example, these results also speak to potential mechanisms explaining prior findings that demonstrate relationships between neural activity in VMPFC and health behavior change (e.g., refs. 42, 45, 46, and 59). The current study provides the first experimental evidence (to our knowledge) that changing activity within VMPFC alters subsequent trajectories of health behavior change. In past work, neural activity in VMPFC during exposure to messages designed to increase sunscreen use (45) and decrease smoking (46, 59) has predicted message-consistent behavior change up to 1 mo after message exposure, but these results have been correlational. The experimental manipulation of neural activity in VMPFC via a self-affirmation manipulation adds substantially to prior findings. It is possible that, in past work, those individuals whose responses to health messages were spontaneously more like those of our affirmed participants (i.e., experiencing self-relevant value in health messages) would have the most success in changing their behaviors. Furthermore, neural responses within VMPFC have forecasted population-level public health campaign success (44). It is possible that, despite not containing explicit affirmations, messages that elicit less defensiveness and more self-related processing across participants are also those that go on to have success at larger scales.

Thus, the current study adds additional confidence concerning psychological processes that may underpin previously observed effects of self-affirmation and also suggests an experimental method for altering activity within VMPFC during other types of interventions that may be of use to investigators in other domains. The use of a scanner-compatible affirmation paradigm allowed us to uncover mechanisms of affirmation on subsequent receptivity to health messaging measured objectively via accelerometers. The study’s longitudinal design also allows examination of affirmation effects that are initially triggered during the scanned intervention and reinforced over time via short message service (SMS) text messages. As with any neuroimaging study, the psychological functions of the neural activity observed should be interpreted with caution pertaining to reverse inference as the VMPFC serves many psychological functions (60). Our strong a priori hypothesis, and convergence with prior research on behavior change, however, suggests that the explanations offered are parsimonious.

Conclusion

In sum, self-affirmation is a method for up-regulating activity within the VMPFC during exposure to health messages. The present findings support a model in which affirmation allows people to see otherwise-threatening information as more self-relevant and valuable. Affirmed (compared with unaffirmed) participants showed greater activity within VMPFC during exposure to targeted health messages and the degree of this activity predicted the trajectory of objectively measured sedentary behavior in the subsequent month. These findings begin to build a picture of the neural mechanisms of affirmation and suggest promise in creation of interventions that prime participants to view information in ways that they can internalize.

Methods

Participants. A community sample of sedentary adults (n = 67; 41 females; mean age, 33.42 y; SD, 13.04; 44 white, 12 black, 3 Asian, 1 Hispanic, 7 other) was recruited for a study on “daily activities” to avoid biasing recruitment in favor of people who would want to sign up for a physical activity study.

Table 1. Whole-brain results comparing neural activity during health message exposure for affirmed > unaffirmed participants, P < 0.005, k = 20

<table>
<thead>
<tr>
<th>Region</th>
<th>x</th>
<th>y</th>
<th>z</th>
<th>k</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventral striatum</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>33</td>
<td>3.41</td>
</tr>
<tr>
<td>Posterior cingulate</td>
<td>−9</td>
<td>−36</td>
<td>13</td>
<td>78</td>
<td>3.41</td>
</tr>
<tr>
<td>Precuneus</td>
<td>1</td>
<td>−70</td>
<td>37</td>
<td>31</td>
<td>3.49</td>
</tr>
<tr>
<td>Superior frontal gyrus</td>
<td>15</td>
<td>36</td>
<td>55</td>
<td>26</td>
<td>3.22</td>
</tr>
<tr>
<td>Middle temporal gyrus</td>
<td>−60</td>
<td>5</td>
<td>−8</td>
<td>33</td>
<td>3.64</td>
</tr>
</tbody>
</table>

No cerebral activity was greater for unaffirmed > affirmed participants.

Fig. 2. (A) VMPFC ROI. (B) Participants who showed higher levels of VMPFC activity during exposure to health messages subsequently decreased their sedentary behavior more in the month following the scan, controlling for baseline sedentary behavior and demographics.
and might be less defensive (Table 2). To be included at the baseline screening, participants had to report engaging in less than 195 min per week of walking, moderate, and vigorous physical activity (using short-form International Physical Activity Questionnaire (IPAQ) criteria, mean reported minutes of activity at intake, 123.53; SD, 49.52). Participants also met standard fMRI safety criteria (no metal in body, not claustrophobic, not pregnant) and were right-handed. Participants with histories of major health problems or mental illness were excluded. On average, participants were overweight [mean body mass index (BMI), 27.99; SD, 6.84; range, 18.2–54.86]. Due to attrition, the final sample consisted of 67 participants at T1, 61 at T2, and 60 participants at T3. In addition, we lost data from an additional 15 subjects due to excessive movement (n = 2) or technical difficulties in scanning (n = 1), equipment failure (n = 11), or damage (n = 1), resulting in a final sample of 45 participants with both neuroimaging and accelerometer data. Years of education was not reported for three participants and age was not reported for one participant. These participants were thus excluded from the analysis (the variables; results remain substantially unchanged, however, with or without these participants. This research was approved by the institutional review board at the University of Michigan.

Procedure (Fig. 3). During screening, participants answered self-report measures of their exercise behavior during the week prior (IPAQ) to identify sedentary adults most in need of intervention (and most likely to be defensive in response to risk messages). They also reported their weight and height. Eligible participants were recruited to complete a baseline appointment (T1), an fMRI appointment (T2) approximately 1 wk later [mean (M), 9.35 d; SD, 6.16], and an endpoint appointment (T3) approximately 1 mo after T2 (M, 35.92 d; SD, 7.19).

At T1, participants completed an initial values ranking that was used in the affirmation intervention, a range of individual difference measures (SI Methods), and baseline measures to calibrate their later activity. More specifically, during the T1 appointment, they were fitted with a wrist-worn accelerometer device used during the duration of the study to monitor participants as they completed a range of activities including walking at their usual pace along a hallway, climbing stairs, and sitting for at least 30 min (calibration). Participants continued to wear the wrist-worn accelerometers for the week between T1 and T2, which served as their baseline (preintervention) activity period.

During the T2 fMRI session, participants completed a series of tasks (described below) including a values-based self-affirmation or control task, and a health message intervention. All tasks were presented on a scanner-compatible screen at 800 x 600-pixel resolution using Presentation (NeuroBehavioral Systems), and responses were collected using a five-button response device attached to the participant’s right wrist.

After the T2 intervention, participants continued to wear their accelerometers for an additional month. In addition, participants received one value affirmation and one health message per day, drawn from the same value and health messages shown during the primary health message intervention, via their mobile phones for a month leading up to their third visit. At the final T3 endpoint visit, participants returned their accelerometers, completed a final set of surveys, and were debriefed, paid, and thanked for their participation.

Measures. Physical activity behavior. Our primary outcome of interest was changes in objectively measured sedentary behavior using accelerometers; given our focus on sedentary adults, and the fact that exchanging sedentary for even light activity is known to have physiological and psychological benefits (17–20), we focused on the proportion of each day that participants were sedentary. More specifically, we collected accelerometer data during a baseline measurement week and for 1 mo following the intervention (Fig. 3) using a triaxial GENEA accelerometer (61) worn on the left wrist (all participants are right-handed; see SI Methods for details). Subjects were encouraged to maintain 247 wear of the water-proof accelerometers for the baseline week before the fMRI appointment and during the month following (62-65).

We defined sedentary behavior according to measurements taken during the T1 laboratory calibration in which participants performed a number of activities including at least 30 min of sedentary activities such as completing surveys while seated at a computer terminal; the peak acceleration during this 30-min period was used to determine appropriate cut points for each participant such that activity below that threshold was tagged as “sedentary.” Using the sedentary cut points defined during the T1 laboratory session, we computed the proportion of each day that participants were sedentary. Demographics and self-report measures. At baseline (T1), participants reported their age, sex, years of education, and race/ethnicity; the race/ethnicity variable was converted into a binary variable indicating white vs. minority status. At baseline (T1) and directly following the scan (T2), participants also completed measures common to several major theories of health behavior change (66) (see SI Methods for full details).

Scanner Tasks. On the day of the T2 scan, participants were randomly assigned between subjects to either a self-affirmation intervention or a control condition that we developed based on standard affirmation paradigms but adapted to the fMRI scanner (54). Following their assigned affirmation or control intervention, they were exposed to messages emphasizing their health risk, given their current levels of sedentary behavior.

Self-affirmation manipulation. At baseline intake (T1), all participants were presented with a list of eight values (i.e., creativity, friends and family, humor, independence, money, politics, religion, spontaneity) and asked to rank order these values in terms of importance to them. During the T2 fMRI intervention session (1 wk later), participants underwent either an affirmation or control manipulation while neural activity was recorded using fMRI. We adapted the commonly used self-affirmation strategy: the use of a single suprasegmental value and value-neutral control situations, identical to the ones presented in the affirmation condition. Through answering value-relevant questions, participants in the self-affirmation condition were provided with an opportunity to think about situations that allowed them to express and connect with their highest ranked value (e.g., if religion was the top-ranked value, “Think of a time when religious values might give you a positive experience,” followed by a value-neutral control situation). Participants in the control condition were presented with a series of situations pertaining to their lowest ranked value and value-neutral control situations, identical to the ones presented in the affirmation condition. For additional details on this task, see ref. 54.

Health message intervention. All participants in both affirmation and control conditions received the same 50 messages targeting sedentary, high-BMI adults (n.sedentary). Each message block consisted of an initial suprasegmental question (5 s), followed by a reason why participants should increase their activity or decrease their sedentary time (7 s), or how participants might think about implementing the suggestions, using simple text and pictograms (Fig. 4). At the end of each block describing why to be less sedentary/more active or

Table 2. Baseline demographic characteristics by condition

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Affirmation (n = 22)</th>
<th>Control (n = 24)</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>33.65 (13.53)</td>
<td>30.09 (13.07)</td>
<td>F = 0.44</td>
</tr>
<tr>
<td>Female, %</td>
<td>56.5%</td>
<td>62.5%</td>
<td>χ² = 0.17</td>
</tr>
<tr>
<td>Caucasian, %</td>
<td>69.6%</td>
<td>66.7%</td>
<td>χ² = 0.20</td>
</tr>
<tr>
<td>Education, y</td>
<td>16.95 (3.29)</td>
<td>16.39 (3.30)</td>
<td>F = 0.48</td>
</tr>
<tr>
<td>Employed, %</td>
<td>78.3%</td>
<td>83.3%</td>
<td>χ² = 0.20</td>
</tr>
<tr>
<td>BMI</td>
<td>27.27 (6.01)</td>
<td>28.01 (4.79)</td>
<td>F = 0.21</td>
</tr>
<tr>
<td>% of day sedentary</td>
<td>46%</td>
<td>54%</td>
<td>F = 3.22*</td>
</tr>
</tbody>
</table>

Mean values are displayed with SDs in parentheses where applicable. *P < 0.10.
how to be less sedentary/more active, participants had a brief reflection period (6 s) in which they were asked to envision how they would apply the information as more self-relevant and valuable; as such, delivering self-affirmation before health messages should increase neural activity in VMPFC during message exposure. To test this hypothesis, we compared neural activity in our VMPFC ROI during exposure to the messages (relative to rest) between participants in the affirmation and control conditions, controlling for baseline levels of sedentary behavior and demographic covariates using linear mixed models (lme4 and lmerTest packages in R [69, 70]). Next, we hypothesized that one mechanism leading to behavior change is that affirmation allows people to see otherwise-threatening information as more self-relevant and valuable; as such, delivering self-affirmation before health messages should increase neural activity in VMPFC during message exposure. To test this hypothesis, we compared neural activity in our VMPFC ROI during exposure to the messages (relative to rest) between participants in the affirmation and control conditions, adjusting for demographics and baseline sedentary behavior, using linear regression in R. Finally, we hypothesized that this same neural activity in VMPFC during message exposure would predict changes in sedentary behavior following the intervention. To test this hypothesis, we examined neural activity in our VMPFC ROI during message exposure as a predictor of the trajectory of sedentary behavior in the month following the scan, controlling for baseline levels of sedentary behavior and demographic covariates using linear mixed models [lme4 and lmerTest packages in R (69, 70)]. Finally, to examine whether neural activity overlaps with what is explained by self-report measures common in major theories of health behavior change, we examined each of our collected self-report variables as a potential predictor of sedentary behavior change in models alone, with VMPFC.

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Supporting Information

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SI Methods

Health Message Intervention. While in the fMRI scanner, participants were exposed to messages promoting physical activity and emphasizing their risk due to sedentary behavior (e.g., “You are at risk. A sedentary lifestyle increases the risk of developing diabetes, hypertension, colon cancer, depression and anxiety, obesity, and weak muscles and bones”; \( n = 10 \)), reasons not to be sedentary (e.g., “The more you sit, the more damage it does to your body. When you sit for long periods of time, your body can’t handle sugar and fat—this can mean higher risk for disease”; \( n = 10 \)), reasons to be more active (e.g., “Exercise can help you deal with stress. Being active can give you a mental break from what’s troubling you, take a step back and make time for yourself”; \( n = 10 \)), as well as tips for how to become more active (e.g., “Move more while you watch TV or watch less. Exchange a portion of your TV watching for something more active—like going for a walk”; \( n = 10 \)) and how to be less sedentary (e.g., “The best parking spots for your health are farther away. Choose the last row of a parking lot or the top floor so that you have farther to walk”; \( n = 10 \); see Fig. 4 for an example block). Each message block consisted of an initial suggestion, followed by a reason why participants should increase their activity or decrease their sedentary time, or how participants might think about implementing the suggestions, using simple text and pictograms. At the end of each block describing why to be less sedentary/ more active or how to be less sedentary/more active, participants had a brief reflection period in which they were asked to envision how they would apply the message in their own life.

SMS Intervention Reinforcement. During the month following the fMRI intervention appointment, participants received two SMS text messages each day, according to their assigned affirmation or control condition. On one-half of the days, participants first received either a text message focusing on their top-ranked value (affirmation condition) or their bottom-ranked value (control condition), and on the other half of the days, participants all received value-neutral messages about everyday activities. These were a subset of the same messages they had viewed during the affirmation task in the scanner. Next, following the first messages, participants received a second text message, which contained one of the messages from the health messages scanner task (advice or benefits of increase activity, the health risks of a sedentary lifestyle, or control messages about everyday activities), as distributed in the scanner task.

Triaxial Accelerometers. Triaxial accelerometer data were collected at 20 Hz and then down-sampled to 1-min epochs to provide a single measure of activity intensity (gravity subtracted signal vector magnitude; SVMg) per minute. These data were visually inspected by a trained research assistant who was blind to study condition and tagged to identify windows of nonwear and sleep. The remaining periods in which participants were awake and wearing the device were subjected to further analysis; data were used for participants on days in which they wore the device for at least 4 h (of 1,772 person days tagged, 1,668 d, or 94%, met this criterion). Previous studies have validated the use of triaxial accelerometers calibrated using specific activities completed in the laboratory (58, 60, 61).

Self-Report Measures Collected. At baseline (T1) and directly following the scan (T2), participants completed measures common to several major theories of health behavior change (62), including their attitudes (10-item semantic differentials, e.g., “I intend to increase my daily physical activity”), self-efficacy (3 items, e.g., “I can increase my daily physical activity”), perceived norms (11 items, e.g., “what percentage of your friends are in the process of increasing their daily physical activity”; “most people who are important to me think I should increase my daily physical activity”), and self-standards (2 items; “I am the type of person who can increase my daily physical activity”) related to physical activity.

fMRI Data Acquisition and Preprocessing. The functional images were recorded using a reverse spiral sequence (repetition time, 2,000 ms; echo time, 30 ms; flip angle, 90°; 43 axial slices; field of view, 220 mm; slice thickness, 3 mm; voxel size, \( 3.44 \times 3.44 \times 3.0 \) mm). A spoiled gradient echo (SPGR) sequence recorded high-resolution T1-weighted structural images (124 slices; slice thickness, 1.02 \( \times 1.02 \times 1.2 \) mm). In-plane T1-weighted overlay images were also acquired (43 slices; slice thickness, 3 mm; voxel size, \( 0.86 \times 0.86 \times 3.0\) mm) to allow two-stage coregistration. Functional data were preprocessed using Statistical Parametric Mapping (SPM8; Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK) for all stages apart from the initial despiking, which was carried out using the 3dDespike program as implemented in the AFNI toolbox. Differences in time of acquisition across the 43 slices were corrected using a sinc interpolation algorithm with the first slice as reference. Then motion artifacts were corrected through spatial alignment to the first slice of each volume. Next the mean image across all blood oxygen level-dependent (BOLD) functional images was coregistered with the in-plane T1 image, and then the high-resolution T1 SPGR image was coregistered to the in-plane T1 image. Following coregistration, the high-resolution T1 images were segmented into white and gray matter, allowing the skull to be removed. Structural and functional images were then normalized to the skull-stripped MNI template provided by FSL (“MNI152_T1_1mm_brain.nii”). In the final preprocessing step, the functional images were smoothed using a Gaussian kernel (8-mm FWHM). To allow for the stabilization of the BOLD signal, the first five volumes (10 s) of each run were discarded before analysis.

SI Results

Relationship Between Self-Report Measures and Behavior Change. We examined the relationship between baseline and postscan self-report predictors collected (attitudes, intentions, self-efficacy, self-standards, norms) and behavior following the intervention, controlling for baseline sedentary behavior and other demographics. Higher perceptions of oneself as the kind of person who can increase their physical activity (self-standards) were associated with lower sedentary behavior overall in the month following the intervention (\( \gamma_{\text{baseline standards}} = -0.057; t = -2.20; P = 0.04 \)). Those who started out perceiving themselves to be the kind of person who can change their physical activity behavior, however, showed lower reductions in sedentary behavior over time than those who did not start out perceiving themselves as being able to change (\( \gamma_{\text{baseline standards}} \times t = 0.002; t = 2.93; P = 0.003; \) controlling for other self-report measures). Those who had more positive baseline attitudes toward physical activity showed faster declines in sedentary behavior in the month following the scan than those with less positive baseline attitudes (\( \gamma_{\text{baseline attitudes}} \times t = -0.0003; t = -2.81; P = 0.005 \)), whereas those with more positive postscan attitudes toward being active were associated with slower declines in sedentary behavior in the month following the scan (\( \gamma_{\text{postscan attitudes}} \times t = 0.002; t = 2.20; P = 0.03 \)), controlling for baseline and other postscan self-report measures.