Self-affirmation activates brain systems associated with self-related processing and reward and is reinforced by future orientation

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Supplementary Material

Participants

Participants were randomly assigned between subjects to either self-affirmation (n=33; mean age=33.33; *SD*=12.43) or control conditions (n=28; mean age=31.63; *SD*=13.65). One person failed to complete the post-scan portion of the study, accelerometer data were not obtained for an additional 12 participants due to equipment failure and damage, and 3 participants were removed from the study due to excess head movement or technical difficulties with the scanner during the health messages task. Therefore, neural results focusing on the neural correlates of self-affirmation are based on a final sample of 61; results validating the effects of affirmation using accelerometer data are based on a subsample of 45 participants (self-affirmation (n=22; mean age=33.27; *SD*=13.72), control condition (n=23; mean age=30.09; *SD*=13.07)). No significant differences in age were found between the control and affirmation participants in the full or subsample, ($t(58)$=-.051, p=.615; $t(43)$=-.798, p=.429; respectively). The results of this investigation come from the same sample and task session as those from Falk et al., 2015, however, the neural processes associated with the actual affirmation task have not been previously examined.

Preprocessing

Functional data were pre-processed and analyzed using Statistical Parametric Mapping (SPM8, Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK; please see supplemental materials for details of preprocessing stream). To allow for the stabilization of the BOLD signal, the first four volumes (eight seconds) of each run were discarded prior to analysis. Functional images were despiked using the 3dDespike program as implemented in the AFNI toolbox. Next, data were corrected for differences in the time of slice acquisition using sinc interpolation; the first slice served as the reference slice. Data were then spatially realigned to the first functional image. We then co-registered the functional and structural images using a two-stage procedure. First, in-plane T1 images were registered to the mean functional image. Next, high-resolution T1 images were registered to the in-plane 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"). Finally, functional images were smoothed using a Gaussian kernel (8mm FWHM).

Region of interest (ROI) definitions

Anatomical ROIs were constructed in the Wake Forest University Pickatlas toolbox within SPM (Maldjian, Laurienti, Kraft, & Burdette, 2003) by combining definitions from the Automated Anatomical Labeling Atlas (Tzourio-Mazoyer et al., 2002), Talairach Daemon database atlas (TD atlas; (Lancaster et al., 2000)), and Brodmann areas, as well as functional meta-analytic findings (Bartra et al., 2013). MarsBar was used to convert these images to ROIs (Brett, Anton, Valabregue, & Poline, 2002). The valuation network ROI was constructed using the functional VS and VMPFC activations found in figure 9 of the Bartra et al. (2013) metaanalysis, examining common regions activated across tasks that focus on positive valuation (for additional details, see; Bartra et al., 2013; Figure 9).

The MPFC and PCC, regions found to be more active during self reflection versus reflecting on others and control tasks (for a review, see; (Lieberman, 2010)) were used to create our self-processing network. The network was constructed by taking the union of the MPFC (all voxels within Brodmann area 10 restricted medially by intersecting a box-shaped mask that extends from x=-20 to 20, y=45 to 70, z=-10 to 30, in order to restrict BA10 medially because of its role in self-related processing compared to more dorsal aspects which are likely involved to greater extents in social cognition; see Lieberman, 2010 for a review) and PCC (the union of the left and right posterior cingulate defined by the TD atlas; (Lancaster et al., 2000)).

Finally, the VLPFC and rACC, regions implicated in regulation of emotion and facilitating difficult choices (Marsh, 2007; Oschner et al., 2004; Wager et al., 2008) were combined to create our emotion regulation network. , the rACC was constructed as the intersection of the anterior cingulate and a box that extends from (x=-25 to 25, y=32 to 45, z=-15 to 32 in order to avoid overlap with the subgenual cingulate and dACC) and the rVLPFC was constructed by taking the union of Brodmann areas 44, 45, and 47 in the right hemisphere.

Figure S1. Regions of interest (ROIs) consist of the positive valuation network (VS+VMPFC), self-related processing network (MPFC+PCC), and emotional regulation network (rACC+rVLPFC).

ROI analysis

We examined independent t-tests on neural activity for those in the affirmed condition versus those in the control condition during key task comparisons to examine main effects of affirmation, as well as interactions with temporal orientation. In addition, to validate the effects of affirmation on behavior in relation to the neural effects observed, linear regression models were run to examine the relationship between neural activity in regions of interest found to be significantly associated with affirmation (value > everyday scenarios for affirmed > control participants) and sedentary behavior change over the month following the intervention. Finally, we used the mediation package in R in order to test indirect effects of affirmation on sedentary behavior through brain activity.

Results

Zero order correlations. Activity in the valuation network (VS+VMPFC) in the future scenario condition (value > control) significantly correlates with changes in sedentary behavior (post – pre), r=-.29, p=.05. Thus, increased activity in the valuation network is associated with greater decreases in sedentary behavior following the intervention. This result was not significant in the past scenario condition, r=.10, p=.51. In addition, activity in the self-processing network (MPFC+PCC) in the future scenario condition (value > control) significantly correlates with changes in sedentary behavior (post – pre), r=-.30, p=.046. Thus, increased activity in the self-processing network is associated with greater decreases in sedentary behavior following the intervention. This result was not significant in the past scenario condition, r=.22, p=.14.

Self-affirmation intervention values versus content. Differences in effects of self-affirmation may be inherently tied to the types of values that humans prioritize (i.e., close others), therefore, additional analyses were run in order to better understand whether the results were driven by the general value one placed on the scenario or by the specific content. Within the current study no significant differences existed within our ROIs (positive valuation, self-related processing, and emotion regulation) for those affirmed with family and friends versus the other possible values (positive valuation network: $t(29)=-.46$, $p=.649$; self-related processing network: $t(29)=-.54$, $p=.592$; emotion regulation network: $t(29)=-.01$, $p=.992$; respectively).