Neural Correlates of Music-Evoked Nostalgia

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Introduction

Nostalgia is an emotionally rich experience, characterized by experience of both positive and negative emotions, and socially-themed autobiographical memories (Barrett, submitted; Batcho, 2007; Routledge, 2008; Wildschut, 2006). Recent investigations have implicated nostalgia as an emotion often triggered by music (Janata, 2007; Juslin, 2008; Zentner, 2008). A recent study has also highlighted the MPFC as a region that may be involved in music-evoked autobiographical memory (MEAM) recall (Janata, 2009). Investigation of music-evoked nostalgia may provide unique insight into the neural basis of emotional experience during memory recall, and may provide us with more information about the neural dynamics of happy and sad emotional experiences.

In this study, we used popular music to evoke nostalgic experiences within participants while they were undergoing an fMRI scan. We also asked participants to complete two different happy and sad emotion induction procedures while being scanned, and compared areas of activation during happiness and sadness induction with areas whose activation tracked increasing strength of nostalgic experience.

Methods

Participants: 11 UC Davis undergraduate students (8 females; age: 18-33; mean: 22.8 +/- 4.4) who had experienced at least 30% music-evoked autobiographical memories (MEAMs) in a music-evoked nostalgia validation study (Barrett, submitted).

Emotion Induction Procedures: block-designed runs with (4) 1" rest periods each, separated by (3) 1" self-paced task periods.

° Velten Procedure
(Velten 1968; Frost 1982; Goritz 2006)

- 3 runs (happiness, sadness, neutral)
- 30 ordered, self-referential statements of increasing emotional intensity.

"Please read each statement carefully and try to put yourself in the mood of a person who might be speaking that statement. Once you have reached this mood state, please press a button to move on to a new statement"

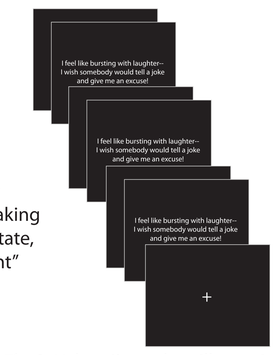


Fig 1. Velten Procedure illustration

° Schneider Procedure
(Schneider 1997; Schneider 2004; Schneider 2007)

- 2 runs (happiness, sadness)
- 40 photographs of actors making facial emotional expressions

"We want you to feel as happy as possible. We will show you pictures of happy faces which can help you to feel the requested emotion. Please look at the faces and try to feel what each person is feeling. You may use as many faces as you need to feel happy. If you want to try a different face, press any button and you will be shown a new face."

Before and after each run, participants gave separate ratings of how happy and how sad they had felt, on the following 5pt scale: Not at all, Weakly, Moderately, Strongly, Extremely.

Nostalgia Procedure: Participants listened to (30) 20s song samples during (2) 13:20" functional runs (15 stimuli per run). After each sample, they rated the degree to which they had experienced Nostalgia, Happiness, Sadness, Autobiographical Memories, and Song Familiarity, on the above 5pt rating scale. A jittered ISI of 1-5s was introduced between the end of each response period and the beginning of the following stimulus.

Song Samples: Songs, chosen from a database of more than 3600 samples downloaded from the Billboard Top 100 Pop, Hip Hop and R&B lists on the Apple iTunes Music Store, were randomly selected from those songs that were released when a given participant was between 8 and 19 years old. Only the first 20s of the samples were played.

fMRI Analysis: Data were analyzed using SPM5. Preprocessing steps included realignment of EPI data with the first volume of each run, coregistration of the reference EPI volumes with a participant's high-resolution structural scan via a coplanar T1-weighted axial image, and spatial normalization of the participant's structural image to the MNI251 T1 template. The normalized images were resliced to conist of 3mm isotropic voxels, and smoothed with a 5-mm isotropic kernel. Data from all runs were concatenated within individual, and a fixed-effects GLM model including motion parameter estimates, stimulus onset regressors, response onset regressors, a "music playing" regressor, and task-related regressors, was fit for each individual.

Responses given after each song during the nostalgia procedure were modeled as parametric modulations of the "music playing" regressor. Each block of each mood induction run was modeled with separate linear regressors, to model increasing mood state as increasing activation over the course of a single block.

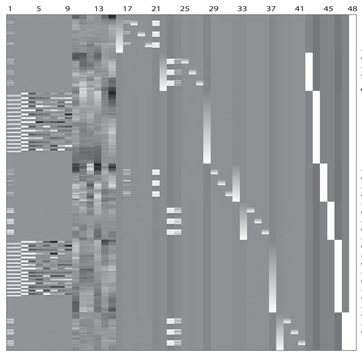


Figure 2. Single-subject design matrix

Results

Nostalgic Experience

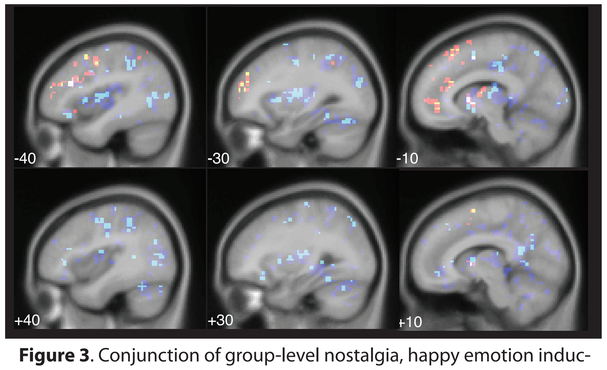
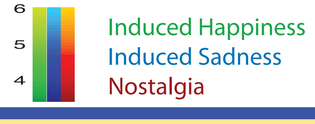


Figure 3. Conjunction of group-level nostalgia, happy emotion induction, and sad emotion induction contrasts. Group-level contrasts show, most notably, MPFC and inferior frontal sulcus activation related to increased strength of nostalgic experience, and posterior insula as well as areas involved in self-referential processing are shown to be active during induced sadness. No consistent activation pattern is shown for induced happiness. Group-level contrasts were thresholded at p < 0.005, voxel extent > 5



Emotion Induction

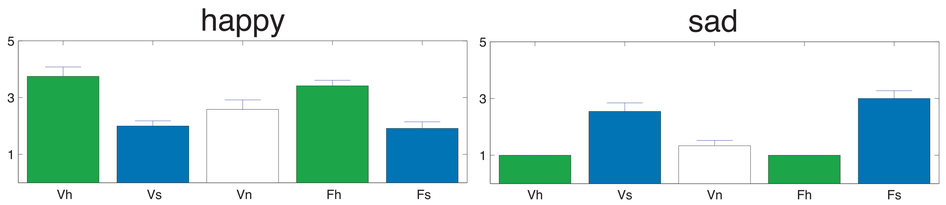
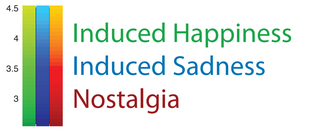


Figure 4. Emotion Induction Ratings. After each emotion induction run, participants rated their happiness and sadness on a 5 point scale. Happiness ratings did not differ between Velten happy and Faces happy runs, nor did sadness ratings differ between Velten sad and Faces sad runs. Happiness ratings during both Velten and Faces happiness induction runs were greater than sadness ratings ($p < 0.01$), and sadness ratings during both Velten and Faces sadness induction runs were greater than happiness ratings ($p < 0.05$).

Participants rated happiness greater than sadness during Velten neutral runs ($p < 0.05$), which suggests that the intended neutral Velten runs may not serve as good controls for target emotion runs in this sample.



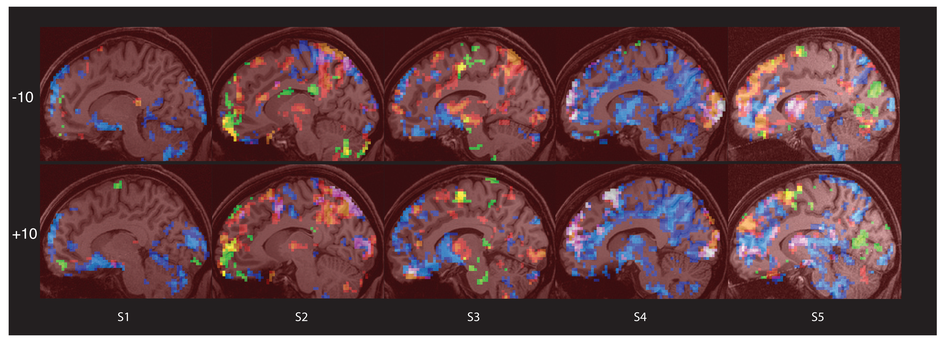


Figure 5. Conjunction of individual nostalgia, happy emotion induction, and sad emotion induction contrasts, from five participants who reported strong nostalgic experiences and strong induced emotion for both happiness and sadness runs. Conjunction of individual mid-line sagittal slices demonstrates overlap between areas active during emotion induction tasks, and areas whose increased activity is correlated with increased strength of nostalgia. Within subjects, activations related to induced happiness and induced sadness show differential profiles of activation in the MPFC. Individual contrasts are thresholded at $p < 0.001$, extent threshold = 10

Conclusions

We used a variety of tasks to evoke nostalgia, happiness, and sadness within individuals. Strength of nostalgic experience was related to increased activation in areas previously found to be related to emotional experience, self-referential processing, and autobiographical recall. These findings are consistent with previous studies of MEAMs and literature on the neural mechanisms underlying autobiographical memory recall, and suggest that MPFC activation is involved in both the experience of emotions, and the recall of emotionally rich nostalgic memories. The degree to which participants differ in activation related to induced mood may be a function of the effectiveness of a particular mood induction method, and differences in mood induction effectiveness should be taken into account in further analyses.

Citations: Batcho, K. I. (2007). American Journal of Psychology, 120(3), 361-381; Barrett, F.B., Grimm, K., Robins, R., Wildschut, T., Sedikides, C., & Janata, P. (submitted). Emotion; Routledge, C., Arndt, J., Sedikides, C., & Wildschut, T. (2008). Journal of Experimental Social Psychology, 44, 132-140; Wildschut, T., Sedikides, C., Arndt, J., & Routledge, C. (2006). Journal of Personality and Social Psychology, 91(5), 975-993; Janata, P. J., Tomic, S. T., & Rakowski, S. K. (2007). Memory, 15(8), 845-860; Juslin, P. N., Liljestrom, S., Vastfjall, D., Barradas, G., & Silva, A. (2008). Emotion, 8(5), 668-683; Zentner, M., Grandjean, D., & Scherer, K. R. (2008). Emotion, 8(4), 494-521; Janata, P. (2009). Cerebral Cortex, epub ahead of print, February 24, 2009; Velten, E. (1968). Behav Res & Therapy, 6, 473-482; Frost, R.O., & Green, M.L. (1982). Personality and Social Psychology Bulletin, 8(2), 341-348; Goritz, A.S., & Moser, K. (2006). Cognition and Emotion, 20(6), 887-896; Schneider, F., Grodd, W., Weiss, U., Klose, U., Mayer, K.R., Nagele, T., & Gur, R.C. (1997). Psychiatric Research, 76, 75-82.

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