Exploring the Neural and Phenomenological Landscapes of Self-Incongruent Autobiographical Memories

Alicja Wicher, Rebekka Heinen, Thomas Lukaschewski, Nikolai Axmacher

Ruhr University Bochum

Abstract

Autobiographical memory recall depends on integrating personal experiences with the self-model, ensuring a coherent identity. Yet self-incongruent memories—particularly those involving shame—disrupt this integration and alter phenomenological characteristics. Building on previous diary study findings linking self-incongruence to changes in recall perspective, our ongoing work develops a novel fMRI paradigm to investigate neural correlates of self-memory integration. In this study, participants recall autobiographical episodes eliciting pride, shame, contentment, or fear, with each memory cued by personalized words. Memory recall is accompanied by free verbal narration and simultaneous recording of physiological measures, including cheek temperature, heart rate, and galvanic skin responses, along with self-report ratings on valence, arousal, and memory experience. Representational Similarity Analysis examines distinct neural signatures across emotional states, while semantic analyses illuminate differences in narrative content. This multimodal, ongoing approach elucidates how self-conscious emotions modulate memory integration across neural, experiential, and semantic dimensions.

Introduction

Remember a moment in your life when you felt proud of achieving something personally meaningful. When this memory comes back to your mind, you remember vivid details, strong emotions, and a clear sense of yourself in that moment. The same can not be said for your last commute or routine grocery shopping. However, we also remember well things we are embarrassed or feel shame about. Why do emotional memories lead to such difference in the quality of your memories? And is this effect related to your self-model?

Autobiographical memory recall depends on the integration of past experiences with the self-model, understood as a dynamic, integrative pattern that unifies diverse self-information into a coherent representation, ensuring that the recall of one's past is congruent with a stable and positive self. However, self-incongruent memories—particularly those associated with shame—pose a challenge to this integration, often leading to changes e.g. in recall perspective, emotional intensity, or semantic structure. Our recent diary study (Lukaschewski et al., 2023) employed an online diary method in which participants recorded daily autobiographical events over a nine-week period. In this study, individuals provided detailed accounts of experiences, categorizing each as shame, guilt, other negative emotions, or neutral. All experiences were then rated on dimensions such as visual perspective and affect. This naturalistic approach revealed that self-incongruent memories systematically alter recall perspective and semantic similarity structure.

While our previous behavioural study focused on the phenomenological and semantic access routes to memory, the next step is to explore how these processes manifest on a neural level. Using functional magnetic resonance imaging (fMRI) allows us to investigate the impact of shame on self-memory integration using the "neural access route", providing insight into the underlying mechanisms that shape self-incongruent memory integration.

Methods

We developed an fMRI paradigm that focuses on the recall of subject-specific autobiographical episodes evoking self-conscious emotions such as pride (positive) and shame (negative) as compared to non-self-conscious episodes that evoke contentment (positive) or fear (negative) (Figure 1). Data collection is ongoing and is scheduled to conclude in July. Forty participants, are being recruited from university populations and the broader community via online invitations and flyers. fMRI data are acquired using a 3 Tesla MRI scanner with a repetition time (TR) of 1200 ms and a voxel size of 1.6 x 1.6 x 1.6 mm.

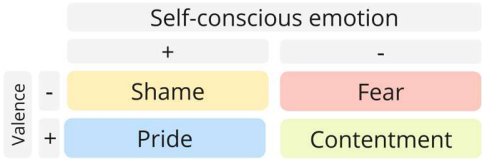

Figure 1: Emotional memory categories.

Memories are initially collected via a questionnaire in which participants provide four memories for each emotional category. For each memory, participants provide three cue words that serve as retrieval cues for the subsequent tasks. For instance, a shameful memory about accidentally spilling a drink on someone might be cued by words

like “cafeteria,” “orange juice,” and “tripped.” During fMRI, subjects are presented with their individual cue words stimuli to initiate the silent memory recall while their brain activity is recorded.

In addition to brain activity, we collect psychophysiological measures of emotional reactivity (e.g., cheek temperature for blushing responses during shame (Nikolić et al., 2024); heart rate for autonomic arousal), qualitative measures of memory phenomenology (e.g., vividness, perspective), and subjective ratings of emotional content (e.g., valence, arousal, emotional category). Participants also perform explicit similarity judgments to characterize how episodes cluster or differ phenomenologically. This integrated approach aims to clarify how self-conscious emotions shape memory recall at neural, physiological, and experiential levels (Figure 2).

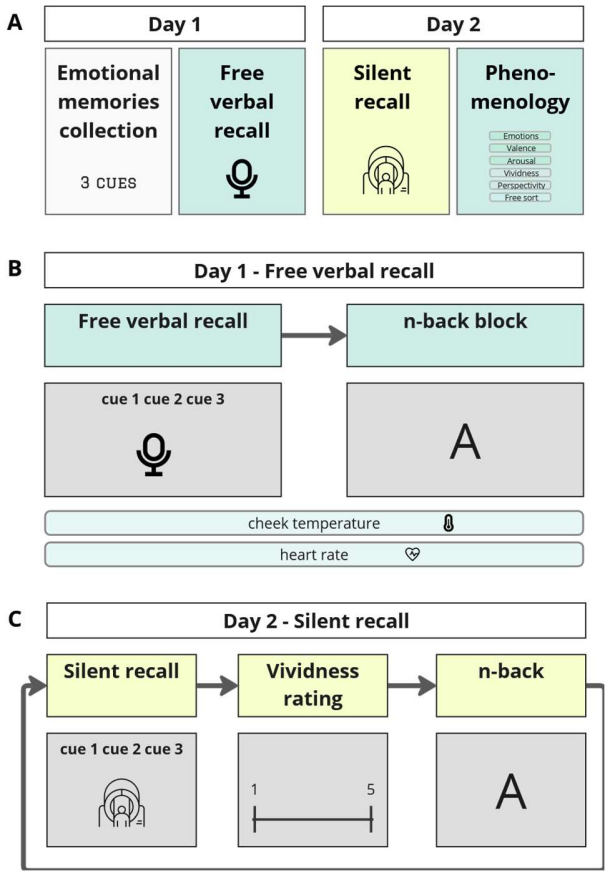

Figure 2: Experimental paradigm.
A.) 2-day experimental paradigm B) Free verbal recall task C.) fMRI silent recall task B.)-C.) Memory recall is followed by the n-back task in order to divert attention and help the induced emotions to fade (Wassing et al., 2019).

Analysis plan

Data analysis is being prepared along with ongoing data collection.

First, we aim to understand the neural basis of self-conscious emotions and how their representations differ compared to self-unconscious emotions. To this end, we will use Representational Similarity Analysis (RSA) (Kriegeskorte et al., 2008) to investigate whether neural representations of different emotional categories exhibit distinct similarity profiles. For example, we will examine whether episodes evoking shame show higher within-category similarity (shame being more similar to other shame experiences) compared to episodes evoking pride or other emotions. RSA will also be used to assess the heterogeneity of neural patterns among episodes within the same emotional category (i.e., will episodes of pride be very distinct from each other or will they generalize across valence dimensions?). This will help determine if all shameful (and other) experiences exhibit similar neural signatures or if there is notable variability within the category.

Linking neural representations to the subjective similarity ratings from our behavioural rating task, we will explore in which brain areas the structure of subjectively rated similarity aligns with the corresponding neural data. this enables us to map the neural correlates of actual perceived memory similarity.

To understand semantic similarity structures between descriptions of the emotional episodes, we will process transcripts of the free verbal recall using large language models (i.e., BERT, Google sentence encoder) to compute semantic similarity scores. We will then compare semantic similarity between different emotional memories categories as well as between the different episodes within each emotion category (i.e., is there a common theme between all shame episodes?) This analysis will clarify whether semantic content differs systematically across categories and episodes.

These analyses including fMRI, language, phenomenal and emotional content linked together with RSA, will give insight on how self-conscious emotional memories are represented in the brain.

Acknowledgements

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