



Task-based Working Memory Functional Brain Networks Detectable by fMRI

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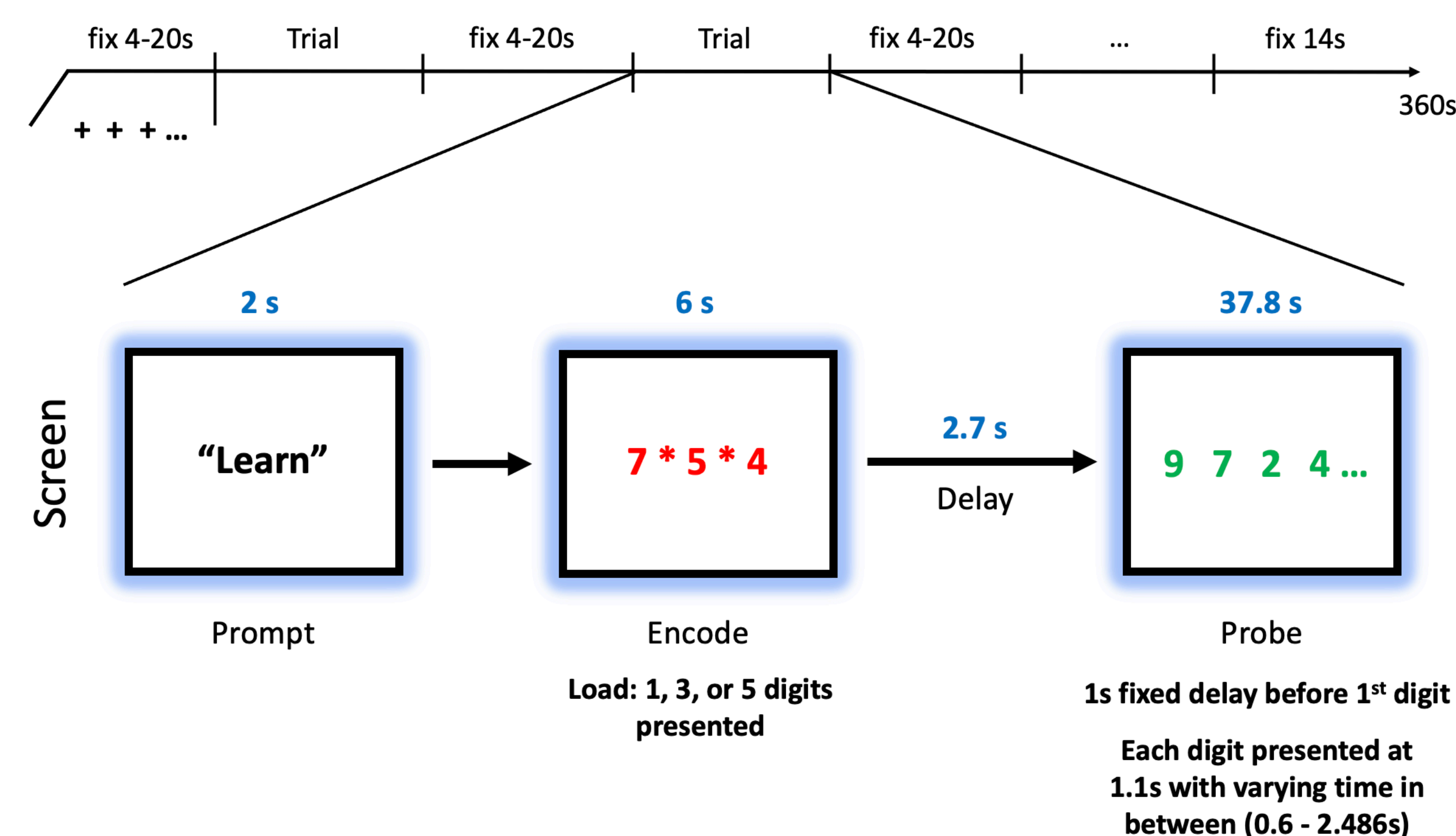
Introduction

In cognitive neuroscience, fMRI investigation of the working memory through analysis of the Sternberg delayed recognition task has been a prominent research area for decades.^[1] However, the field has yet to arrive at a consensus for a set of macroscale functional brain networks.^[2] The present study utilized a version of the task called Sternberg Item Recognition Paradigm (SIRP).^[1] We hypothesized the emergence of the Working Memory Big Five brain networks that were established in previous research.^[3,4]

- Response Network:** activates when an individual makes a response.^[3,4]
- Focus on Visual Features Network:** is upregulated when perceived visual details are deemed important for attention.^[3,4]
- Initiation Network:** is elicited when restarting a required cognitive process after a short break.^[3,4]
- Internal Attention Network:** shows activity when attention is focused on an internal representation such as working memory.^[3,4]
- Default Mode Network:** displays suppression until a response is made.^[3,4]

Methods

- Patients with schizophrenia or schizoaffective disorder (n=87) and healthy subjects (n=79) completed the SIRP task in the fMRI scanner. They were asked to indicate if the **probe digits** were members of the **memory set**.



- Constrained Principal Component Analysis for fMRI (fMRI-CPCA) was applied on fMRI data to identify and characterize functional brain networks elicited by the task their associated hemodynamic responses (HDR).^[5]
- Analysis of Variance was used to determine effects of conditions: group (healthy or schizophrenia), load (1, 3, or 5 digits), and post-stimulus time.

Results

Four functional brain networks were extracted from the fMRI-CPCA analysis

- Response Network and Initiation Network demonstrated load dependency: the more digits to be memorized, the higher the response.
- Initiation Network and Auditory Attention for Response Network showed significant difference in HDR between healthy and schizophrenia.
- Internal Attention Network was potentially merged into the extracted Response Network.
- Traditional Default Mode Network had no clear peaking or load dependency.

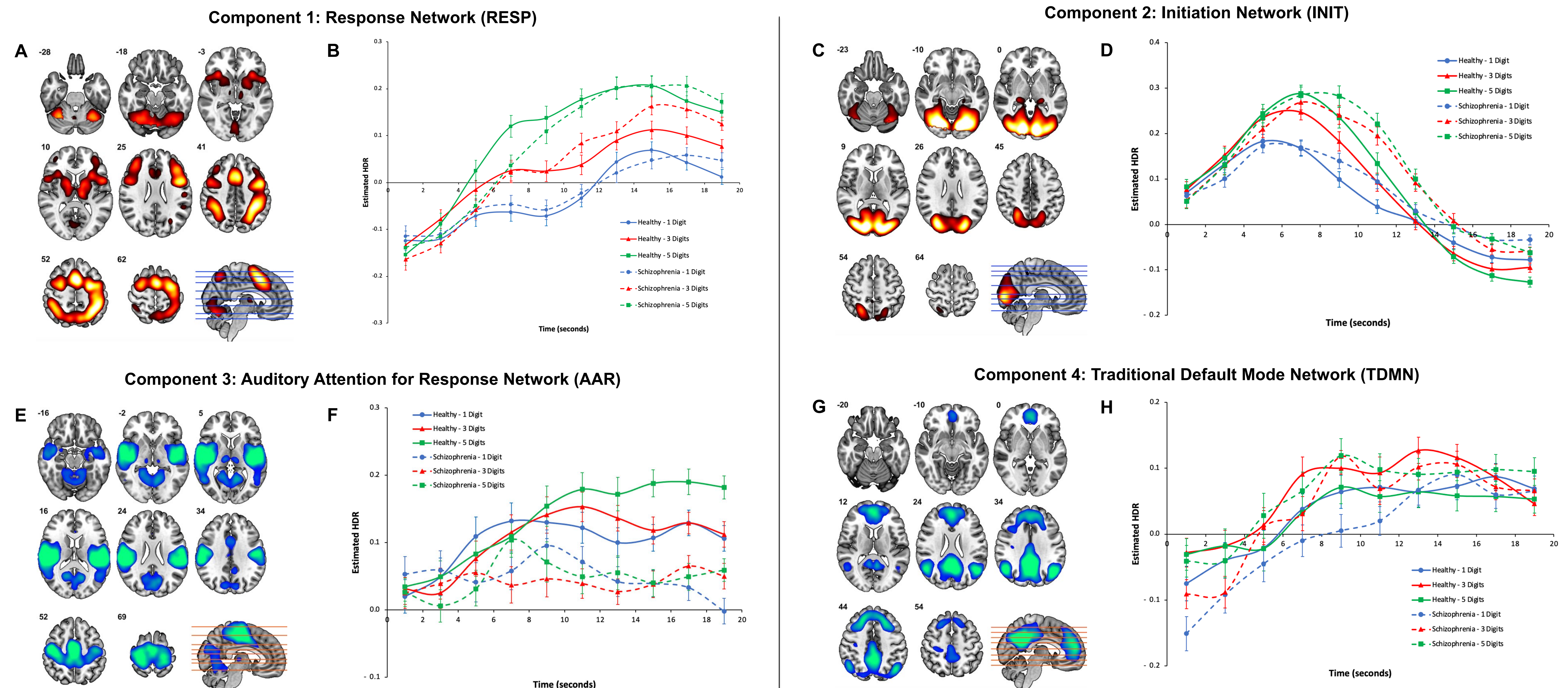


Figure 1. A,C,E,G: Dominant 10% of loadings for RESP, INIT, AAR, TDMN networks respectively (red/yellow = positive loadings, blue/green = negative loadings; A: threshold = 0.12, max = 0.22; C: threshold = 0.11, max = 0.36; E: threshold = -0.10, min = -0.18; G: threshold = -0.08, min = -0.16). Images are displayed in neurological orientation (left is left). B,D,F,H: Mean finite impulse response (FIR)-based predictor weights plotted over post-stimulus time by group and task condition for RESP, INIT, AAR, TDMN networks respectively. Positive predictor weights reflect increased signal in the networks. HDR = hemodynamic response.

Discussion

- AAR network underwent deactivation when participants had to shift focus away from auditory stimuli and towards visual details of digits on the screen.
- INIT and AAR networks have reduced activity in schizophrenia patients, implicating their dysfunction may underlie cognitive impairments in schizophrenia.
- Further studies can analyze a longer time window of the task trial to elicit all networks in the Big Five.
- Future research should investigate the effect of site difference, sex differences in brain networks, and neuropathological differences between schizophrenia and schizoaffective disorder.
- Meaningful correlations with symptoms can be established, which will contribute to the discovery and development of advanced treatment options.

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