Supplementary Martials

A. Procedures of 7 Tasks

Working Memory. Participants are presented with blocks of trials that consisted of pictures of places, tools, faces and body parts. Within each run, the 4 different stimulus types are presented in separate blocks, and 1/2 of the blocks use a 2-back working memory task and 1/2 use a 0-back working memory task. A 2.5s cue indicates the task type at the start of the block. Each run contains 8 task blocks (10 trials of 2.5s each, for 25s) and 4 fixation blocks (15s each). On each trial, the stimulus is presented for 2s, followed by a 500ms ITI.

Gambling. The participants play a card guessing game where they are asked to guess the number on a mystery card (represented by a "?") in order to win or lose money. They are told that potential card numbers range from 1 to 9 and to indicate if they think the mystery card number is more or less than 5 by pressing one of two buttons on the response box. Feedback is the number on the card (generated by the program as a function of whether the trial was a reward, loss or neutral trial) and either: 1) a green up arrow with "$1" for reward trials, 2) a red down arrow next to −$0.50 for loss trials; or 3) the number 5 and a gray double headed arrow for neutral trials. The "?" is presented for up to 1.5s (if the participant responds before 1.5s, a fixation cross is displayed for the remaining time), following by feedback for 1.0s. There is a 1.0s ITI with a "+" presented on the screen. The task is presented in blocks of 8 trials that are either mostly reward (6 reward trials pseudo randomly interleaved with either 1 neutral and 1 loss trial, 2 neutral trials, or 2 loss trials) or mostly loss (6 loss trials interleaved with either 1 neutral and 1 reward trial, 2 neutral trials, or 2 reward trials). In each of the two runs, there are 2 mostly reward and 2 mostly loss blocks, interleaved with 4 fixation blocks (15s each).

Motor. In this task, the participants are presented with visual cues that ask them to tap their left or right fingers, squeeze their left or right toes, or move their tongue to map motor areas. Each block of a movement type lasts 12s (10 movements), and is preceded by a 3s cue. In each run, there are 13 blocks, with 2 of tongue movements, 4 of hand movements (2 right and 2 left), 4 of foot movements (2 right and 2 left) and three 15s fixation blocks per run.

Language processing. This task consists of two runs that each interleave 4 blocks of a story task and 4 blocks of a math task. The lengths of the blocks vary (average of approximately 30s), but the task was designed so that the math task blocks match the length of the story task blocks, with some additional math trials at the end of the task to complete the 3.8min run as needed. The story blocks present participants with brief auditory stories (5–9 sentences) adapted from Aesop's fables, followed by a 2-alternative forced choice question that asks the participants about the topic of the story. The example provided in the original Binder paper [1] is "For example, after a story about an eagle that saves a man who had done him a favor, participants were asked, 'That was about revenge or reciprocity?'" The math task also presents trials aurally and requires the subjects to complete addition and subtraction problems. The trials present the subjects with a series of arithmetic operations (e.g., "Fourteen plus twelve"), followed by "equals" and then two choices (e.g., "twenty-nine or twenty-six"). The participants push a button to select either the first or the second answer. The math task is adaptive to maintain a similar level of difficulty across the participants.

Social cognition. The participants are presented with short video clips (20s) of objects (squares, circles, triangles) either interacting in some way, or moving randomly. These videos were developed by either Castelli et al. [2] or Wheatley et al.[3]. After each video clip, the participants chose between 3 possibilities: whether the objects had a social interaction (an interaction that appears as if the shapes are taking into account each other's feelings and thoughts), Not Sure, or No interaction (i.e., there is no obvious interaction between the shapes and the movement appears in random). Each of the two task runs has 5 video blocks (2 Mental and 3 Random in one run, 3 Mental and 2 Random in the other run) and 5 fixation blocks (15s each).

Relational processing. The stimuli are 6 different shapes filled with 1 of 6 different textures. In the relational processing condition, the participants are presented with 2 pairs of objects, with one pair at the top of the screen and the other pair at the bottom of the screen. They are told that they should first decide what dimension differs across the top pair of objects (shape or texture) and then they should decide whether the bottom pair of objects also differs along that same dimension (e.g., if the top pair differs in shape, does the bottom pair also differ in shape). In the control matching condition, the participants are shown two objects at the top of the screen and one object at the bottom of the screen, and a word in the middle of the screen (either "shape" or "texture"). They are told to decide whether the bottom object matches either of the top two objects on that dimension (e.g., if the word is "shape", is the bottom object the same shape as either of the top two objects). For the relational condition, the stimuli are presented for 3500ms, with a 500ms ITI, with four trials per block. In the matching condition, stimuli are presented for 2800ms, with a 400ms ITI, with 5 trials per block. Each type of block (relational or matching) lasts a total of 18s. In each of the two runs of this task, there are 3 relational blocks, 3 matching blocks and three 16s fixation blocks.

Emotion processing. The participants are presented with blocks of trials that ask them to decide either which of two faces presented on the bottom of the screen match the face at the top of the screen, or which of two shapes presented at the bottom of the screen match the shape at the top of

the screen. The faces have either angry or fearful expressions. Trials are presented in blocks of 6 trials of the same task (face or shape), with the stimulus presented for 2s and a 1s ITI. Each block is preceded by a 3s task cue ("shape" or "face"), so that each block is 21s including the cue. Each of the two runs includes 3 face blocks and 3 shape blocks.

B. Brain Activation Maps of Six tasks

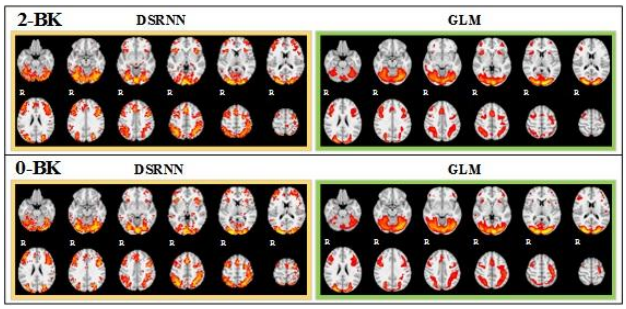

Fig. 1. Activation maps of working memory task.

Working Memory. Fig. 1 shows the activation maps of 2-back and 0-back events. In the activation map of 2-back and 0-back, dorsal parietal cortex, dorsal anterior cingulate, and bilateral dorsal and ventral prefrontal cortex, which are thought to be involved in a cognitive control network are activated. Further, activation in occipital cortex can be easily observed. Meanwhile, some deactivation can be seen in medial prefrontal cortex, posterior cingulate, and the occipital–parietal junction, which belongs to the default mode network. The activation areas of 0-back are quite similar with those of 2-back, and the critical activation regions match well in DSRNN and GLM results.

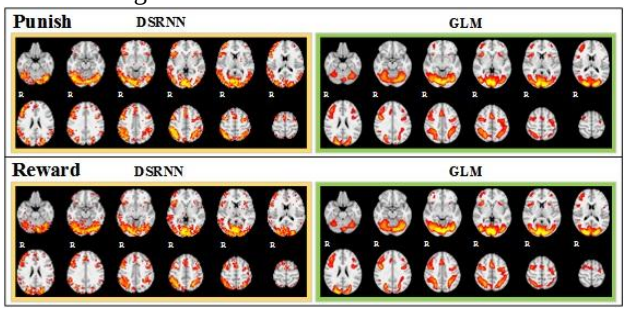

Fig. 2. Activation maps of gambling task.

Gambling. Fig. 2 illustrates the activation map from the gambling task which is designed to assess reward processing and decision making. In Fig. 2, brain regions including bilateral striatum and bilateral insula, which are thought to be critical components of the reward system, are activated. Because the striatum and the medial frontal cortex are believed to be activated in both event blocks, activation maps of both events resemble very much.

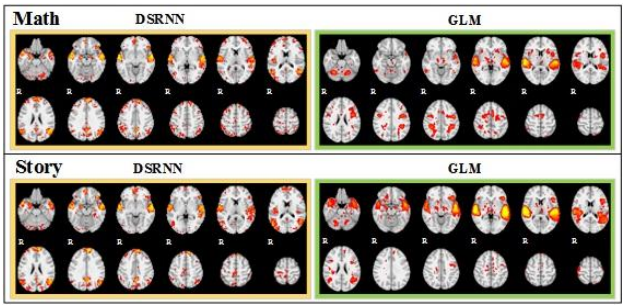

Fig. 3. Activation maps of language task.

Language. In Fig. 3, both story and math activation maps are shown. Prefrontal cortex, temporal cortex, and lingual gyrus of the occipital lobe are activated robustly in language task. Meanwhile, bilateral temporal cortex are activated strongly, as well as inferior parietal.

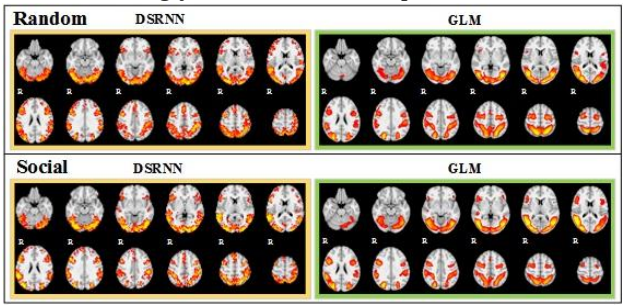

Fig. 4. Activation maps of social cognition task.

Social. As shown in Fig. 4, several regions which are thought to be related with social cognition are activated, such as superior temporal cortex regions, temporal parietal junction, etc. Further, the activation in temporal parietal and superior temporal regions are distinguishing to identify the social to the random block.

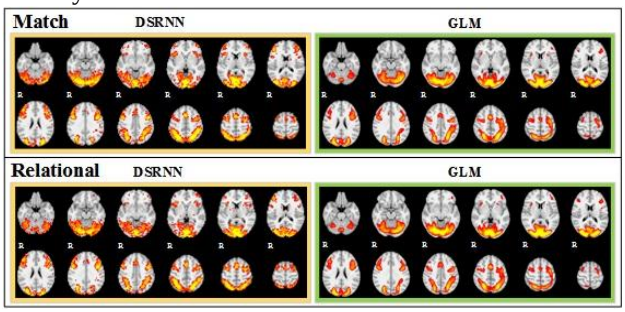

Fig. 5. Activation maps of relational task.

Relational. This task was designed to assess brain region of anterior prefrontal cortex. In Fig. 5, robust activations in bilateral anterior prefrontal cortex are elicited in relational task.

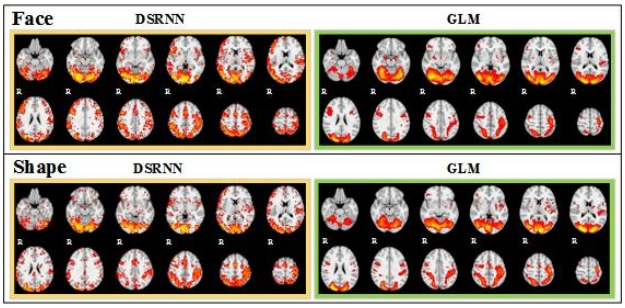

Fig. 6. Activation maps of emotion task.

Emotion. In the activation map of fearful face, it is easy to appreciate that visual regions are widely activated. Since fearful face stimulus are implement to subjects, fusiform face area is robustly activated. Meanwhile, there is also some activation in regions of ventral temporal cortex.

REFERENCES

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[3] T. Wheatley, S.C. Milleville and A. Martin, Understanding Animate Agents: Distinct Roles for the Social Network and Mirror System, *Psychological Science*, vol. 18, (no. 6), pp. 469-474, 2007.