

*Additional Details About Cognitive Measures**WMC Tasks*

Complex Span Task Practice. Each of the 4 complex span tasks began with 4 trials of practice with sets of 2 – 3 memory items alone (with no processing task), followed by 15 trials of practice with just the processing task alone (with no memory items), followed by 3 trials of practice combining the memory and processing task.

Operation Span (OPERSPAN). Target letters (F, H, J, K, L, N, P, Q, R, S, T, Y) appeared for 1000 ms each. In selecting items for serial recall, subjects could choose a “blank” option for any forgotten letters, in order to preserve item order. When subjects selected a letter, it appeared on the bottom of the screen in the order (from left to right) in which it was selected.

Reading Span (READSPAN). Target words (*Bald, Cuff, Dunk, Fuse, Glow, Hush, Jolt, Limb, Mole, Nest, Pail, Ramp, Soak, Tint, Wool*) appeared for 1000 ms each.

Symmetry Span (SYMMSPAN). Target red squares appeared for 650 ms. For the recall phase, when a red square was clicked, it turned red with a number inside it to indicate its serial position (as in the other tasks, there was a “blank” option to allow forgotten items while preserving serial order).

Rotation Span (ROTASPAN). Target arrows were large (255 pixels long; 32 pixels wide at widest point) or small (85 pixels long; 23 pixels wide at widest point), radiating from center in one of 8 directions (12:00, 1:30, 3:00, 4:30, 6:00, 7:30, 9:00, 10:30). Each arrow appeared for 650 ms. The processing letters were rotated at 0, 45, 90, 135, 180, 225, 270, or 315°. For the recall phase, the 8 larger arrows extended from behind the 8 small arrows; when an arrow was clicked, a number appeared on it to indicate its serial position (there was also a “blank” option to allow forgotten items while preserving serial order).

Running Span (RUNNSPAN). Letters (F, H, J, K, L, N, P, Q, R, S, T, Y) appeared at a rate of two per second. As in the complex span tasks, at recall the subject could select a “blank” option for any

forgotten letters, in order to preserve item order. When subjects selected a letter, it appeared on the bottom of the screen in the order (from left to right) in which it was selected.

Updating Counters (COUNTERS). During the learning phase, each digit appeared for 1250 ms with a 100 ms blank between them. The updating phase began 100 ms after the learning phase, and presented each update operation (e.g., +2; -5) for 1333 ms, followed by a 250 ms blank. At recall, subjects used the number keypad to enter the value for each box.

Attention Restraint Tasks

Antisaccade Letters (ANTI-LET). On each trial, the central-fixation array of asterisks for appeared for 200, 600, 1000, 1400, or 1800 ms; target letters were presented in Courier New font. The flashing “=” cue was presented for 100 ms, blanked for 50 ms, presented again for 100 ms, and blanked again for 50 ms. The target letter was pattern-masked after 100 ms by the sequence of an H (for 50 ms) then 8 (until response or 10 s, whichever came first). Subjects’ key-press response was followed by a 400 ms blank screen. Response keys were the bottom row of three arrow keys (located between the letter keys and the number keypad), with each labeled by a sticker as corresponding to B, P, or R, respectively, from left to right. Subjects began with 36 trials of letter-identification practice (12 trials for each letter) with the target letters presented and masked at central fixation, and then completed 12 trials of practice with the antisaccade task.

Antisaccade Arrows (ANTI-ARO). On each trial, a central-fixation array of three asterisks appeared for 250, 750, 1250, 1750 or 2250 ms; arrow stimuli appeared in wingdings 3 bold font. The flashing cue was a “=” presented for 80 ms, blanked for 50 ms, presented again for 80ms, and blanked again for 50 ms. The target arrow was pattern-masked after 80 ms by the sequence of a “+” (for 50 ms) then a “❖” symbol (until response or 10 s, whichever came first). Subjects’ key-press response was followed by a 400 ms blank screen. Subjects began with 20 trials of arrow-identification practice (5 trials per arrow orientation), with the arrows presented and masked at

central fixation. (During the first semester of data collection, cues and targets appeared for 150 ms and 100 ms, respectively; as noted in the main text, the task data from these subjects were dropped.)

Semantic Sustained Attention To Response Task (SEM-SART). Each word was pattern masked by an X-string (XXXXXXXXXXXX), with words and strings in 18 point Courier New font. The 675 test trials were preceded by 10 unanalyzed buffer trials, which were preceded by a block of 10 practice trials presenting boy's names ["go"] and girl's names ["no-go"]. Different stimulus words were presented in each of the 5 trial blocks, but due to a programming error all of the block 5 animals were also drawn from blocks 1 and 2, and all of the block 5 vegetables were identical to those from block 4).

Number Stroop (N-STROOP). Each trial began with a 1000 ms blank screen. Digits appeared in Courier New 24 pt font. Response keys were the keyboard's B, N, and M keys were labeled with stickers as "2," "3," and "4," respectively; subjects rested their right index, middle, and ring fingers on the keys. Preceding test blocks, subjects practiced response mapping in two blocks of 36 trials; the first presented 2, 3, or 4 red squares; the second presented rows of 2, 3, or 4 "#", "@", or "?"s.

Spatial Stroop (S-STROOP). On each trial, the word and asterisk appeared 50 pixels apart, with the asterisk presented 300 pixels away from fixation. Words appeared in 18 point Calibri font. Each trial began with a 250 ms fixation cross, followed by a 500 ms blank screen, followed by the stimulus. Preceding the test blocks, subjects completed 48 practice trials; in the first block they responded to strings of Xs relative to an asterisk (32 trials) and in the second, they completed 12 practice trials with actual stimuli. After this task, subjects completed a second trial block with different task demands that we do not analyze here.

Attention Constraint Tasks

Arrow Flanker (ARROFLNK). Subjects responded to left arrows by pressing the "Z" key (labeled with an "L" sticker) and to right arrows with the "/" key (labeled with an "R" sticker).

Targets and distractors appeared in sans serif 12-point font; stimulus arrays were 10 pixels tall and 40-50 pixels wide, with 1-4 pixels between items. Each trial began with a 500 ms blank screen; fixation crosses appeared for 350 ms and target-distractor arrays appeared until response. Practice consisted of 10 trials of response mapping to centrally presented arrows without flankers, and then 10 with flankers.

Letter Flanker (LETTFLNK). Subjects responded to leftward-facing (backwards) letter Fs by pressing the “Z” key and to rightward (normal) Fs with the “/” key. Targets and distractors were created as sans serif bitmap letters (e.g., F) of 12 × 16 pixels; stimulus arrays were approximately 180 pixels wide, with 16 pixels between each stimulus. Each trial began with a 750 ms blank screen; fixation crosses appeared for 600 ms and target-distractor arrays appeared until response. Practice consisted of 10 trials of response mapping to centrally presented letters without flankers, and then 10 with flankers. Twenty-four trials of an additional, exploratory trial type are not analyzed here.

Conditional Accuracy Flanker (ACCYFLNK). Subjects responded to each array by pressing the “A” key (covered with a green sticker) for H targets and the “” key (covered with a blue sticker) for S targets. Stimuli appeared in 16-point Courier New Bold font; arrays spanned 2.1 cm horizontally. Each trial began with a variable inter-trial interval (500, 1000, 1500, 2000 ms); the fixation dot appeared for 500 ms, the warning tone for 50 ms, and then a 1000 ms black screen preceded the target array. The target array was followed by a 1000 ms blank screen to capture the response, and then by either a 1000 blank screen or the “Deadline Missed. Faster!” warning screen. Prior to the test trials, subjects practiced response mapping to 10 congruent arrays and then to 16 mixed arrays (8 congruent, 4 S-R conflict, 4 S-S conflict).

Masked Flanker (MASKFLNK). Distractor stimuli appeared 10 pixels above and below the target and 8 pixels to the left and right; all letters appeared in 10 point Courier New Bold font. Each array appeared 40 cm above or below the center of the screen; location dot cues appeared for 500

ms, followed by a blank screen for 1100, 1700, or 2300 ms. Each stimulus item was followed by a pattern mask (“#”) for 10 s or until response; the next trial began after a 250 ms blank screen. The non-allowable distractors presented on S-S conflict trials were A, B, C, E, and S. Thirty-six trials of an additional, exploratory trial type are not analyzed here. Prior to the actual test trials, subjects practiced response mapping to above- or below-fixation target letters without flankers (12 trials) and then with flankers (10 trials). Dependent measures for S-R conflict were error rates for S-R incongruent trials and congruent trials, and for S-S conflict were error rates for S-S incongruent trials and neutral trials.

Cued Search (CUEDSRCH). Subjects pressed the “Z” key (covered with an “L” sticker) for a leftward-facing backwards letter and the “/” key (with an “R” sticker) for a rightward-facing normal letter. Two symbols served as 4-location cues, with arrowheads at each endpoint: A “+” symbol cued the locations directly above, below, to the left, and right of the central location, and an “x” symbol cued the four corner locations of the internal 3 × 3 matrix. Four symbols cued two locations: Each was a straight line with arrowheads on each end, oriented to indicate the to-be-searched locations, with a vertical line cuing the locations above and below center, a horizontal line cuing the locations to the left and right of center, and diagonally slanted lines cuing opposing vertices of the internal 3 × 3 matrix (e.g., “/” for lower left and upper right). All stimuli were sans serif bitmap letters (e.g., F) of 11 × 15 pixels; stimulus arrays were 106 × 120 pixels (4.9 × 5.7 cm) in size. Each trial began with a 500 ms blank screen. The 2- or 4-location cue appeared for 500 ms, followed by blank for 50 ms. The 1500 ms fixation grid was followed by a 50 ms blank screen, and then the stimulus array for 4000 ms or until response. Prior to test trials, subjects practiced response mapping to target letters appearing amid dots (8 trials) and then amid distractors (12 trials).

Circle Flanker (CIRCFLNK). On each trial, the two distractors were selected randomly with the constraint that both distractors were not the same; due to a programming error, however, M was

slightly over-represented among distractors and some trials presented two Ms. Stimuli appeared in 12 point Arial Bold, in one of 8 equidistant locations in a circular arrangement (radius of 48 pixels). Fixation crosses appeared for 750 ms central fixation cross; the variable blank screens appeared for 500, 1000, 1500, or 2000 ms and the target-distractor array until response. Sixteen trials of an exploratory trial type were not analyzed here. Prior to the test trials, subjects practiced response mapping to 30 target-only arrays and then to 10 mixed arrays (5 neutral, 5 S-S conflict).

Thought Probes

For the Semantic SART task, each probe was followed by a 1000 ms blank screen before the next stimulus appeared. For Number Stroop, probes always appeared 1000 ms after an incongruent trial and probe responses were followed by a 1000 ms blank screen. For Arrow Flanker, probes always followed a 350 ms fixation screen, and after each probe response, a new screen appeared for 2000 ms reminding subjects to return their index fingers to the response keys; half the probes followed S-S conflict trials and half followed S-R conflict trials. For Letter Flanker, probes immediately followed the stimulus array. For 2-Back, subjects completed 240 trials (divided into 5 seamless blocks of 48 trials each); words appeared for 500 ms followed by a 2500 ms fixation screen. Five of each 1- and 3-back lure type appeared in each blocks. Three probes appeared per block, with 2 following targets and 1 following a lure, with each immediately following the stimulus item.