

Supplementary Methods

Cognitive task description

Choice Reaction Task (action initiation):

Participants first saw a fixation square in the center of the computer screen. They were instructed to focus their attention on this fixation point. Next, a series of dark gray-colored arrows appeared, one at a time, in the same central location. The arrows could point in the rightward or leftward direction. Participants were instructed to respond to the direction of the arrow using handheld grips in their left and right hands, with left pointing arrows calling for a left hand button press and right pointing arrows calling for a right hand button press. An arrow appeared and remained on the screen until a participant pressed a button. Next, an intertrial interval randomly selected between 750-1250 milliseconds (ms) in increments of 50 ms transpired before the next arrow appeared. The fixation point was visible at all times except when an arrow was being presented on the screen. Participants were instructed to respond as quickly and accurately as possible to each arrow.

Participants were exposed to an equal number of left and right pointing arrows (randomly presented and counterbalanced). Participants completed a practice session of 16 trials and 96 experimental trials. It took 5 minutes to complete the Choice reaction task.

Stop-Signal Task (action cancelation):

The stop-signal task was identical to the choice reaction task with one major difference. On 30% of trials, a gray-colored arrow first appeared, but after a brief delay, the arrow changed color from gray to purple. This color change served as a stop signal that instructed participants to try to stop or inhibit their button response to the arrow's direction. Participants were instructed to respond fast to the direction of gray arrows and not to delay responding in anticipation of the presentation of stop signals. On these stop trials,

the delay between the onset of the gray arrow and the color change (i.e., stop-signal delay, or SSD) adjusted dynamically using a 50 ms staircase-tracking procedure that was based on the participant's success or failure to stop on the previous stop trial {21}. If the participant successfully stopped on a stop trial, the SSD on the next stop trial would increase by 50 ms to increase the difficulty of stopping, while a failure to stop a reaction on a stop trial led to a shortening of the SSD on the next stop trial in order to make stopping easier. The dynamic tracking procedure converged on an overall 50% response stopping rate on stop trials, which is optimal for obtaining a reliable estimate of stop signal reaction time (SSRT) {22}

Participants completed a practice session of 40 trials followed by 3 blocks of 90 experimental trials comprised of 189 go trials and 81 stop trials. On average, it took less than 10 minutes to complete the Stop task.

Stop signal reaction times were estimated using the horse-race model and integration method. The horse-race model assumes an independent race between the go and stop processes. The onset of the stop process is experimentally controlled by the length of the SSD. The finishing time of the stop process is inferred from the time point at which the internal response to the stop-signal occurs and subtracting the SSD from this point. The time point in the go reaction time (GoRT) distribution that corresponds to P (failure-to-stop) is assumed to equal (SSD + SSRT). Individual GoRTs were rank ordered and the nth GoRT was selected, where n is the point at which P (failure-to-stop). The mean SSD was then subtracted from this finishing time to obtain an estimate of SSRT.

Simon task (interference control)

For the Simon task participants were instructed to respond to the direction of an arrow that would appear left or right of a fixation point in the center of the screen. Participants responded by means of hand held button grips to a series of left and right pointing arrows that were presented one at a time on the computer screen. The beginning of a block of trials was signaled by the appearance of a small, centrally located black-colored square (i.e., a fixation point) against a dark grey-colored screen. The fixation point

remained on the screen for the entire duration of a block of trials. Following the initial appearance of the fixation point, a leftward or rightward pointing arrow (length 2.1 cm; visual angle 1.14°) appeared 0.6 cm (0.34° visual angle) to the left or to the right of fixation and remained on the screen until the participant either made a response or a 1000 millisecond (ms) time limit elapsed. Next, a variable intertrial interval of 750 to 1250 ms elapsed before the next trial was initiated by the appearance of another arrow.

Participants were instructed to respond as quickly and as accurately to the direction of the arrow (e.g., left-pointing arrow = left button press; right-pointing arrow = right button press). Left and right pointing arrows were presented randomly and with equiprobability across each block of trials.

To elicit the Simon effect, two trial types were presented to the patients: Corresponding (Cs) trials, where the arrow appeared to the side of fixation that matched the response side, signaled by the direction that the arrow pointed (e.g., a right pointing arrow calling for a right-hand response appeared to the right visual half-field). Non-corresponding (Nc) trials, in which the arrow appeared on the side of fixation opposite the side of the response signaled by the direction it pointed (e.g., a right pointing arrow calling for a right-hand response appeared to the left visual half-field), see figure 1b. Cs and Nc trial types were presented randomly and with equiprobability within each block of trials.

Reaction times (RT) and accuracy were measured for each trial, and the Simon effect was estimated as Nc trials minus Cs trials for RT and error rates. For the Simon task, participants completed a practice session of 16 trials followed by 3 blocks of 90 experimental trials comprised of an equal number of Nc and Cs trials. On average, it took less than 10 minutes to complete the Simon task.