

The Task-Switch Cost Is Still Absent After Selectively Stopping a Response in Cued Task Switching

Participant-visible method context. Results, discussion, captions, and the target figure are excluded.

Participants Participants were recruited from the Prolific subject pool (<https://prolific.co>) in all four experiments. The selection criteria included (a) having normal or corrected-to-normal vision without color blindness, (b) being fluent in English, (c) being at the age between 18 and 45, and (d) having submitted more than 20 responses on the Prolific platform with an approval rate of at least 95%. We aimed

to recruit 60 participants per experiment and achieved a minimum of 55 participants in each of the four experiments, which is sufficient to achieve a statistical power of .9 to detect a medium effect size (Cohen's $f = .25$ or $\eta^2_p = .06$) in a fully within-subject design. In Experiment 1, 65 participants completed the experiment, but six were removed for a low accuracy rate (below 70%), leaving 59 participants (33 females, 25 males, one nonbinary; Mage = 33.00, SD = 7.55, range = 19–45) in the analysis. In Experiment 2, 74 participants completed the experiment, but 14 participants were removed for a low accuracy rate, leaving 60 participants (38 females, 22 males; Mage = 32.05, SD = 6.36, range = 20–45). In Experiment 3, 74 participants completed the experiment, but 19 were removed for a low accuracy rate, leaving 55 participants (40 females, 15 males; Mage = 30.35, SD = 7.65, range = 18–45). In Experiment 4, 76 participants completed the experiment, but 20 were removed for a low accuracy rate, leaving 56 participants (32 females, 22 males, two nonbinary; Mage = 31.63, SD = 7.96, range = 18–45). All participants gave informed consent for participation online. The experimental protocol was approved by the Research Ethics Committee of the Department of Psychology at the University of Essex.

Apparatus and Stimuli Experiments 1–4 were all conducted online when in-person interactions were restricted due to the global pandemic. All experiments were developed and controlled by Inquisit 6 (Millisecond Software, LLC). Participants downloaded Inquisit Player to their own computers and completed the experiment. They were required to use either a Windows or Macintosh computer, and no mobile devices (e.g., tablet or smartphone) were allowed. The sizes of stimuli varied depending on participants' monitor size. The measures of visual stimuli reported in this section were based on a screen resolution of 1,920 × 1,080 on a 13-in laptop monitor. The task instructions emphasized both speed and accuracy of responding. All experiments consisted of two different tasks (color vs. shape). In the color task, one key was assigned to red stimuli and the other key to green stimuli; in the shape task, one key was assigned to squares and the other key to diamonds. The assignments of the colors and the shapes to the two response keys were counterbalanced across participants. These two tasks were intermixed randomly in each block. One of the tasks was indicated by the task cue at the beginning of each trial; the task cue for the color task was either COLOUR or HUE, and that for the shape task was either SHAPE or FORM. The cues were presented in the Arial font and appeared 3.5 cm above the screen center. There were two types of trials: full-task trials, for which participants responded to the target on every trial; and selective go/nogo trials, for which participants responded only to the targets assigned to one response key (selective go) and withheld responding to the targets assigned to the other response key (selective nogo). The four experiments differed with respect to how and when these trial types were cued to participants. The stimulus display and timing are illustrated in Figure 1. Each trial started with a task cue that stayed on the screen for 400 ms, followed by a 100-ms blank screen. The target stimulus appeared for 2,000 ms in Experiments 1–3 and for 400 ms followed by a blank display for 1,600 ms in Experiment 4, or until a response was made. The target stimuli were green and red squares (2 cm on each side) and diamonds (the square stimuli tilted 45°), which appeared at the center

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Figure 1 Illustrations of the Stimulus Presentation and Timing in Experiments 1–4

Note. In all experiments, a trial started with a task cue, followed by a 100-ms blank. Experiments 1 and 2 presented the target and go/nogo signal simultaneously, and Experiments 3 and 4 first presented the target and then a go/nogo signal 400 ms after the target. See the online article for the color version of this figure.

NO TASK-SWITCH COST AFTER SELECTIVE STOPPING

of the screen. On full-task trials, participants were shown a target and responded to it as quickly as possible before the trial ended. In Experiments 1 and 2, the target appeared alone on full-task trials. In Experiments 3 and 4, the word “Go” was presented to indicate that participants were to make a response to the target regardless of the hand to be used. On selective go/nogo trials, participants were presented with a target along with a selective go/nogo signal and responded to the target when the target feature assigned to one response key appeared but withheld responding until the trial ended when the target feature assigned to the other response key appeared. In Experiment 1, the selective go/nogo signal was a grey square frame (3.2 cm on each side) surrounding the target. In Experiments 2–4, it was a letter “L” or “R.” As the latter indicated which hand was to be used to make a response, we call it the hand cue. Responses were registered by pressing the “S” and “L” keys on a keyboard, which were referred to as the left and right response keys in the instructions. For full-task and selective go trials, the message “Correct!” was presented if participants made the correct response; otherwise, the message was “Error!” for an incorrect response and “Faster!” for no response. For nogo trials, the message was “Correct!” if no response was made, or “Don’t respond!” if either response key was pressed. The message stayed on the screen for 500 ms. RT was measured as the interval between the onset of the target stimulus (Experiments 1 and 2) or the go/nogo signal (Experiments 3 and 4) and the depression of a response key. The next trial started with another task cue. In Experiment 1, each participant performed two phases, each consisting of one block of 15 practice trials and three blocks of 120 test trials each. Half of the test trials were full-task trials where participants were presented only with the target and responded to it regardless of the required response. The other half were selective go/nogo trials where a grey frame was presented around the target, and participants responded to the target only if the target required a designated response (selective go trials) and withheld responding to the target that required the other response (selective nogo trials). In one phase, the designated response was the left response, and in the other phase, it was the right response. Participants were informed of the designated response in the instructions before the respective blocks started. The order of the designated responses was randomly determined for each participant. In Experiment 2, the responding hand on selective go/nogo trials varied on a trial-by-trial basis. On these trials, the target appeared with a hand cue. When the hand cue was “L,” participants were to respond to the target only if the target required the left response (selective go trials), but to withhold responding if it required the right response (selective nogo trials); when the hand cue was “R,” they were to respond if the target required the right response but to withhold responding if it required the left response. The two letters could appear randomly with equal probability. Full-task trials were the same as those in Experiment 1. Each participant performed two blocks of 16 practice trials, followed by six blocks of 120 test trials each. Half of these trials in each block were full-task trials, and the other half were selective go/nogo trials. In Experiment 3, the only change from Experiment 2 was that there was a 400-ms delay between the target and a go/nogo signal. Selective go/nogo signals were the same hand cues as those used in Experiment 2, but the signal “Go” was presented in the place of the hand cue for full-task trials, which prompted responding to the target regardless of the required hand. RT was the interval between the

onset of one of these signals (rather than that of the target) and a keypress. Thus, when participants pressed a response key before the hand cue or go signal occurred, RT was recorded as a negative value, but participants still saw the same feedback messages for correct (“Correct”) or error responses (“Error”) on these responses as they would have for a response that followed the signal. These trials with negative RTs were not included in the analysis. There were three blocks of 12 practice trials, followed by six blocks of 120 test trials each. In Experiment 4, the target was erased after 400 ms and replaced by a go/nogo signal (“Go” for full-task trials and “L” or “R” for selective go/nogo trials). The go/nogo signal was now presented in black. The procedure followed Experiment 3 in all other respects.

Data Analysis The main analyses focused on RT and percentage of error trials (PE) on full-task trials. The number of selective go/nogo trials was not sufficiently large to warrant separate analyses, but we report the analyses of selective go and nogo trials in the Supplemental Materials. The analyses and visualization were carried out in R Studio (R Core Team, 2021) with the following packages: tidyverse (Wickham et al., 2019), BayesFactor (Morey & Rouder, 2022), afex (Singmann et al., 2023), multcomp (Hothorn et al., 2008), emmeans (Lenth, 2022), and ggpubr (Kassambara, 2022). Trials were discarded when no response was made or when the response was incorrect on the immediately preceding trial. In Experiments 1 and 2, trials were also discarded when RT was shorter than 200 ms. This resulted in 13.56% of trials being discarded in Experiment 1 and 15.23% in Experiment 2. For Experiments 3 and 4 for which there was a 400-ms delay of a go/nogo signal onset, trials were discarded when RT was a negative number (i.e., participants responded before the hand cue/go signal occurred) rather than when RT was less than 200 ms; this resulted in 17.02% being discarded in Experiment 3, and 13.47% in Experiment 4. Mean RT for correct responses and PE were computed for each participant. They were submitted to

separate 3 (Previous Trial: full-task vs. selective go vs. selective nogo) $\times$ 3 (Trial Sequence: cue-repeat vs. cue-switch vs. task-switch) analyses of variance (ANOVAs), with both variables being within subject. For Trial Sequence, cue-repeat trials were those for which the task cue was the same as that on the preceding trial, and participants performed the same task as on the preceding trial (e.g., "COLOUR" $\rightarrow$ "COLOUR"). On cue-switch trials, the task cue was different from that on the preceding trial, but participants still performed the same task as on the preceding trial (e.g., "COLOUR" $\rightarrow$ "HUE"). On task-switch trials, the task cue was different from that on the preceding trial, and participants performed a task different from that on the preceding trial (e.g., "COLOUR" $\rightarrow$ "SHAPE"). These three types of task transition occurred with an equal probability (.33) on each trial and in a random order. Because the main purpose of the present study was to examine the presence or absence of switch costs after different types of trials, multiple comparisons were carried out to evaluate the cue-switch and task-switch costs. We report *p* values that were not corrected for multiple comparisons and adopted a Bonferroni-corrected α ($= 0.05/2 = .025$) to decide whether these costs were statistically significant. The cue-switch cost was computed by subtracting RT and PE for cue-repeat trials from those for cue-switch trials, and

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Experiment 1

the task-switch cost was computed by subtracting RT and PE for cue-switch trials from those for task-switch trials. For each of these switch costs, we computed the Bayes Factor (BF) based on a two-tailed one-sample *t* test against the null hypothesis that a switch cost was absent ($= 0$). The default prior to the BayesFactor package was used for all calculations of BFs. BF greater than 1 would indicate evidence supporting the presence of a switch cost, whereas BF less than 1 would indicate evidence supporting the absence of a switch cost. For the presence of a switch cost, BF greater than 3 was taken as moderate evidence and BF greater than 10 as strong evidence; for the absence of a switch cost, BF less than .33 was taken as moderate evidence and BF less than .10 as strong evidence. BF between .33 and 3 was taken as inconclusive evidence for either the absence or presence of a switch cost.

Experiment 1 intermixed full-task and selective go/nogo trials, and the latter trials were cued with a grey frame surrounding the target. The response to be withheld on selective nogo trials was fixed within each block of trials. For RT, the ANOVA showed significant main effects of Previous Trial and of Trial Sequence, and a significant interaction between them. Responses were generally fastest after full-task trials ($M = 729$ ms), intermediate after selective go trials ($M = 772$ ms), and slowest after selective nogo trials ($M = 805$ ms). Responses were also fastest on cue-repeat trials ($M = 740$ ms), intermediate on cue-switch trials ($M = 753$ ms), and slowest on task-switch trials ($M = 813$ ms). After full-task trials, the cue-switch cost was 31 ms ($p < .001$, $BF > 100$), and the task-switch cost was 125 ms ($p < .001$, $BF > 100$). After selective go trials, the cue-switch cost was 12 ms ($p = .278$, $BF = .25$), and the task-switch cost was 83 ms ($p < .001$, $BF > 100$). After selective nogo trials, the cue-switch cost was -4 ms ($p = .693$, $BF = .15$), and the task-switch cost was 11 ms ($p = .416$, $BF = .24$). For PE, the main effect of Previous Trial was not significant, but the main effect of Trial Sequence and its interaction with Previous Trial was significant. Responses were most accurate on cue-repeat trials ($M = 5.36\%$), intermediate on cue-switch trials ($M = 5.55\%$), and least accurate on task-switch trials ($M = 9.52\%$). After full-task trials, the cue-switch cost was -0.28% ($p = .68$, $BF = .15$), and the task-switch cost was 5.28% ($p < .001$, $BF > 100$). After selective go trials, the cue-switch cost was $.37\%$ ($p = .652$, $BF = .16$), and the task-switch cost was 5.13% ($p < .001$, $BF > 100$). After selective nogo trials, the cue-switch cost was -0.50% ($p = .425$, $BF = .19$), and the task-switch cost was 2.10% ($p = .030$, $BF = .52$). Overall, the task-switch cost was significant after full-task and selective go trials both in RT and PE, and the corresponding BFs

Transparency and Openness The raw trial data, the analysis scripts, and the experimental programs are available on the Open Science Framework project page at <https://osf.io/c8hw7/> (Yamaguchi & Swainson, 2024). We reported how we determined our sample size in the Participants section in the Participants section above. The design and its analyses were not preregistered. All data in Experiments 1–4 were collected between February 2022 and March 2022. Experiment 5 (reported in a later section) was conducted in February 2024 as per a reviewer's suggestion.