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Abstract

How do we stop ourselves during ongoing action? Recent work implies that stopping *per se* is easy given sufficient monitoring of contextual cues signaling the need to change action. We test key implications of this idea for improving inhibitory control. Seven- to 9-year old children practiced stopping an ongoing action, or monitoring for cues that signaled the need to go again. Both groups subsequently showed better response inhibition in a Stop-Signal task than active controls, and practice monitoring yielded a dose-response relationship. When monitoring practice was optimized to occur while children engaged in responding, the greatest benefits were observed – even greater than from practicing stopping itself. These findings demonstrate the importance of monitoring processes in developing response inhibition, and suggest promising new directions for interventions.

Keywords: cognitive control, inhibitory control, context monitoring, cognitive development, intervention.

While dining out, your phone buzzes. As you reach for it, your friend's look reminds you this is rude. How do you manage to stop mid-reach? People must often stop themselves during ongoing actions – when making insensitive comments, reaching for tempting desserts, or sending emails without promised attachments. Poor response inhibition during childhood predicts reduced academic achievement, health, and income later in life (Blair & Razza, 2007; Moffitt et al., 2011). Deficits in response inhibition are associated with developmental disorders such as ADHD and autism (Alderson, Rapport, & Kofler, 2007; Luna, Doll, Hegedus, Minshew, & Sweeney, 2007). Thus, understanding and improving response inhibition and its development are of prime importance.

Most theories of response inhibition focus on cognitive and neural processes specialized for stopping *per se*. For example, interrupting the reach for a phone may depend most on processes specialized for inhibiting motor output. Such motoric stopping has been posited as a function of the right inferior frontal gyrus (rIFG) (Aron & Poldrack, 2006; Aron, 2011; Chambers, Garavan, & Bellgrove, 2009). rIFG is activated by the Stop-Signal task, in which participants perform a simple choice reaction task (e.g., pressing once on the same side as a target) unless a stop signal appears, in which case responses must be withheld (Verbruggen & Logan, 2008). rIFG activation is negatively correlated with the latency of response inhibition (Aron & Poldrack, 2006; Rubia, Smith, Brammer, & Taylor, 2003). Conversely, response inhibition is slowed when rIFG is damaged (Aron, Fletcher, Bullmore, Sahakian, & Robbins, 2003) or temporarily deactivated (Chambers et al., 2006).

However, recent work demonstrates the importance of monitoring the environment for contextual cues that signal the need to change action (Chatham et al., 2012; Dodds, Morein-Zamir, & Robbins, 2011; Hampshire, Chamberlain, Monti,

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Duncan, & Owen, 2010; Sharp et al., 2010). Interrupting the reach for a phone may depend most on successfully monitoring for relevant signals, like a friend's disapproval. Evidence comes from tasks with different motoric demands but matched context-monitoring demands (e.g., Stop-Signal vs. a task that requires pressing a second time if a signal appears). Signatures of response inhibition (e.g., rIFG activation, relevant event-related potentials, and pupillometric measures) more closely track monitoring demands than motoric-stopping demands, and behavioral measures of context-monitoring efficacy, but not stopping efficacy, predict both response inhibition performance and associated rIFG activation (Chatham et al., 2012).

The present studies test a counterintuitive implication of this account for intervention: The practice of *responding a second time* if a signal appears should improve the subsequent ability to *stop* when the same signal appears, because of the common demand to monitor for the signal and despite the mismatch in trained motor actions. By way of analogy, imagine trying to improve a child's inhibition of hitting a playmate by first teaching that child to monitor for a relevant environmental signal, such as a disapproving adult, and to then hit the playmate twice! We tested this prediction in children, given greater trainability in childhood (Wass, Scerif, & Johnson, 2012), and suggestions that interventions in childhood are influential for outcomes (Diamond & Lee, 2011). We focused on 7- to 9-year-old children because they can engage control proactively (Chatham, Frank, & Munakata, 2009), and should therefore benefit from practice monitoring for signals before they appear.

Experiment 1

In Experiment 1, 7- to 9-year-old children practiced either motoric stopping, with an attempt to minimize context monitoring demands, or context monitoring with no stopping demands. A third group practiced neither monitoring nor stopping but

The practice of stopping helps children to stop received similar experience otherwise. At test, all children performed a Stop-Signal task requiring monitoring for the same signal as in Context-Monitoring practice, and withholding responses, as in Motoric-Stopping practice.

Methods

Participants

Study participants included 88 7- to 9-year-old children in Experiment 1 (mean age = 8.4 years, *SD* = 0.5; 48 boys and 40 girls). Parental informed consent and children's assent were obtained prior to participation. Children received small prizes and parents received $5 compensation for travel.

Materials and Procedure

All participants were tested individually in a 1-hour session. Children completed three experimental tasks, while the parent sat behind them.

Initial assessment of response inhibition (10 min.). Response inhibition was first assessed by digit identification accuracy on an Antisaccade task. Antisaccade and Stop-Signal performance correlate, and both tasks load onto the same latent factor in adulthood (Miyake et al., 2000; Friedman et al., 2008). (The Stop-Signal task was not used here to avoid interference between an initial experience with the task and later practice or test performance.) Children sat 60 cm from the screen and fixated a centrally presented cross. After a variable delay (ranging from 1500 and 3500 ms), a black square appeared on one side of the screen for 350, 375 or 400 ms, followed by a digit on the opposite side for 150 ms, which was then masked. Given this rapid timing, successful digit identification required inhibiting fixating the initial stimulus in order to quickly look in the opposite direction to identify the digit. After a warm-up series of 16 prosaccade trials and 6 antisaccade trials, children completed 3 × 18 test antisaccade trials.

Practice phase (30 min.). Children were randomly assigned to the Motoric-Stopping condition ($N = 29$), Context-Monitoring condition ($N = 27$), or the Control condition ($N = 32$) (Fig. 1). Preliminary analyses showed that groups did not differ in age ($M_{Monitoring} = 8.4$ years; $M_{Stopping} = 8.3$ years; $M_{Control} = 8.4$ years), $p = .878$, sex distribution (Monitoring: 15 boys/12 girls; Stopping: 14 boys/15 girls; Control: 19 boys/13 girls), $p = .680$, or antisaccade score ($M_{Monitoring} = .44$, $SD = .21$; $M_{Stopping} = .39$, $SD = .20$; $M_{Control} = .39$, $SD = .19$), $p = .538$, suggesting they were comparable at study entry.

In the Motoric-Stopping condition, an airplane (target) appeared either on the left or right side of the screen on each trial. Children helped an air controller by pressing on the same side as the airplane to make it land. Feedback was provided in the form of an airplane being added to or removed from the bottom of the screen. After two demonstration and 24 warm-up trials trials, Signal trials were introduced: after a variable delay, the background color turned dark gray, clouds and lightening appeared below the target along with a thunder sound. The use of salient perceptual information as stop signals was intended to minimize context-monitoring demands by facilitating the detection of the need to stop. These trials required withholding responding because the storm made it is too dangerous to land. The signal was presented after one of the following delays: 20%, 30%, 40% or 50% of each child's mean RT. These values were fixed throughout the practice phase to allow children to gauge improvement. To discourage slowing strategies, a response time limit of 1.5 × the child's mean reaction time (computed based on the initial warm-up series of trials) was introduced on No-Signal trials.

The Context-Monitoring condition was identical to the Motoric-Stopping condition, except for the following changes. Children had to feed yellow bananas

The practice of stopping helps children to stop (targets) to an adult monkey. Feedback was provided by adding or removing a banana at the bottom of the screen. Critically, on Signal trials, the yellow banana turned brown (cue) after a variable delay. Children were instructed to quickly press again to make brown bananas go away because the monkey did not like those. The time limit for the first press was 1.1 × the child's mean RT and 1.0 × the child's mean RT for the second press. These values, set based on pilot participants, ensured that this condition was roughly as challenging and yielded the same amount of positive/negative feedback as the Motoric-Stopping condition.

A Control condition used the same cover story, targets and cue as in the Context-Monitoring condition to ensure that any potential difference in test performance could not relate to differences in materials familiarity. However, children were instructed to press (once) on the same side as the banana on both No-Signal and Signal trials (i.e., irrespective of whether the banana remained yellow or turned brown). In addition, Picture trials, where a cartoon character was presented and children were instructed to just wait, kept children engaged and ensured that they did not build a stronger prepotency to respond. There were 27 No-Signal trials, 9 Signal trials, and 12 Picture trials in each block.

Test phase (10 min.). At test, all children completed the same Stop-Signal task (Fig. 1), which contained 24 warm-up trials without Signal trials, 24 warm-up trials with Signal trials, and 3 test blocks containing 36 No-Signal and 12 Signal trials each. Children had to feed yellow bananas to a baby monkey on No-Signal trials. On Signal trials, after a variable delay, the banana turned brown in which case children were instructed to withhold responding to make it go away. Therefore, children had to monitor for banana color changes, as in the Context-Monitoring condition, but withhold responding, as in the Motoric-Stopping condition. We used the same signal

The practice of stopping helps children to stop across practice and test in the Context-Monitoring condition to maximize the transfer from monitoring for a signal; however, this design also maximizes the additional demand of overcoming a prepotent response to this signal at test. In contrast, cues differed between practice and test in the Motoric-Stopping condition to maximize benefits attributable to common stopping demands, rather than monitoring.

Inhibitory control at test was indexed by the Stop-Signal Reaction Time (SSRT), an estimate of how efficiently responses can be stopped; faster SSRTs indicate better inhibitory control (Band, van der Molen, & Logan, 2003). Stop signal delay was adjusted following a staircase procedure (Verbruggen & Logan, 2009): the signal delay was increased by 50 ms after successfully inhibited responses and decreased by 50 ms after errors on Signal Trials (unless the delay was already 0 ms).

Bayesian Model. A parametric Bayesian method estimated the entire distribution of SSRTs using three parameters (see Supplemental Materials and Balota & Yap, 2011; Matze, Dolan, Logan, & Wagenmakers, 2012; Matzke, Love, Wiecki, Brown, Logan, & Wagenmakers, 2013): μ (mu) for the mode (i.e., mean of the Gaussian component), σ (sigma) for its dispersion (i.e., standard deviation of the Gaussian component), and τ (tau) for its positive skew (i.e., scale of its exponential component). These estimates of the entire distribution of SSRTs are more meaningful than the standard calculation of mean SSRT, because they capture the fact that SSRTs vary across trials and they provide a more reliable measure with smaller numbers of trials (Matze et al., 2012). We focus primarily on μ as the leading edge of the SSRT distribution and the modal time required for successful response inhibition; we consider implications of other measures in the General Discussion. Each estimate was analyzed separately for Signal and No-Signal trials with an ANOVA using condition

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as independent variable and age as a covariate. Significant effects were further probed

with Bonferroni-corrected contrasts.

Results and Discussion

Practice influenced inhibitory control, as indicated by all three estimates of

SSRT distributions, μ: $F(2, 84) = 13.25$, $p < .001$, $\eta^2_p = .240$, σ: $F(2, 84) = 85.21$, p

$< .001$, $\eta^2_p = .670$, and τ: $F(2, 84) = 12.79$, $p < .001$, $\eta^2_p = .234$ (Figure 2A). Children

showed faster modal response inhibition after practicing context monitoring (μ = 247

ms) or motoric stopping (μ = 243 ms), relative to controls (μ = 288 ms), ps $< .001$.

SSRTs were also less dispersed in the Context-Monitoring condition (σ = 46 ms) and,

to a lesser extent, in the Motoric-Stopping condition (σ = 52ms), relative to controls

(σ = 65 ms), ps $< .001$, although the distribution of SSRT showed a longer tail in the

Context-Monitoring condition (τ = 170 ms) and, to a lesser extent, in the Motoric-

Stopping condition (τ = 137 ms) than in the Control condition (τ = 104ms), ps $< .037$.

In contrast, estimates for reaction times on No-Signal trials did not differ across

conditions, ps $< .368$, suggesting the benefits of practice did not reflect greater

motivation (Figure 2B).

As training-related improvement can predict cognitive control gains (e.g.,

Jaeggi et al., 2011), we examined whether performance improved over practice (Table

1) and predicted response inhibition at test. Children responded increasingly fast in

the Motoric-Stopping and Context-Monitoring conditions. In the Context-Monitoring

condition only, the magnitude of this improvement (reduction in No-Signal RTs and

first-press latency on Signal trials) predicted response inhibition (smaller μ SSRT), r

$= -.586$, $p < .001$, and $r = -.382$, $p = .049$, respectively. A linear regression, using the

backward procedure, showed that only change in Signal RT significantly explained

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variance in μ SSRT, $\beta = -.85$, $t(25) = -3.61$, $p < .001$, adjusted $R^2 = .317$, $F(1, 25) =$ 13.05, $p < .001$ (Figure 3).

This relation between improvement during practice and response inhibition at test suggests a way to increase the effectiveness of context-monitoring practice. Faster responding over the course of practice likely reflects children learning to monitor while engaged in responding, as opposed to monitoring for relevant cues and engaging in responding only after the cue has appeared or is unlikely to. Monitoring while engaged in action (i.e., after action initiation) is crucial for successfully inhibiting an ongoing action at test. Therefore, context-monitoring practice should be even more effective at improving response inhibition if children can be further encouraged during practice to monitor for the cue while engaged in responding.

Experiment 2

We built on the dose-response relationship between improvement during Context-Monitoring practice and response inhibition to optimize practice in Experiment 2. We tried to encourage children to learn to monitor while engaged in responding, by making the cue transient and increasing time pressure on the first press. We predicted that this new condition should reduce modal SSRTs at test relative to the conditions from Experiment 1.

Method

Participants, Materials and Procedure

Thirty-two children participated in Experiment 2 (mean age = 8.3 years, $SD =$ 0.5; 14 boys and 15 girls). They did not significantly differ in mean age, sex distribution (17 boys/15 girls) or antisaccade score ($M = .39$, $SD = .19$) from children in the other conditions, all $ps > .685$. Materials and procedure were identical to Experiment 1. Participants completed the Simultaneous-Monitoring condition, which

The practice of stopping helps children to stop was similar to the Context-Monitoring condition, with two changes. First, time pressure for the first press on Signal trials was increased (1.0 × the child's mean RT) whereas that on the second press was decreased (1.2 × the child's mean RT) in order to encourage children to engage in responding quickly on the first press while keeping overall time pressure constant. Second, the banana flashed brown for 100 ms before turning back to yellow (instead of remaining brown) to encourage constant monitoring while engaged in responding.

Results and Discussion

ANOVAs including all four conditions showed effects of condition on all three SSRT estimates, μ: $F(3, 115) = 35.18$, $p < .001$, $\eta^2_p = .479$, σ: $F(3, 115) = 88.10$, $p < .001$, $\eta^2_p = .697$, and τ: $F(3, 115) = 31.42$, $p < .001$, $\eta^2_p = .450$ (Figure 2A). Most importantly, children showed faster modal response inhibition after practicing simultaneous-monitoring ($\mu = 201$ ms) relative to every other condition, ps < .001 (Figure 2A). The dispersion in the Simultaneous-Monitoring condition ($\sigma = 63$ ms) was greater than in the other practice conditions, ps < .001, while not differing from controls, $p = .595$. The skew was also greater ($\tau = 211$ ms) than the other conditions, ps < .009. Again, no differences in No-Signal reaction times reached significance, ps > .493. Performance improved during Simultaneous-Monitoring practice, but did not correlate with SSRT estimates, ps > .407 – consistent with the dose-response relationship arising from individual differences in context monitoring in Experiment 1 that we reduced with Experiment 2's optimizations.

General Discussion

These studies demonstrate that children's response inhibition can be improved through practice monitoring for contextual cues that signal the need to change action. The practice of context monitoring while engaged in action improved subsequent

The practice of stopping helps children to stop modal response inhibition more than practice with motoric stopping itself. Moreover, although we tried to minimize context-monitoring demands in the stopping condition, children may have nonetheless monitored for the perceptually salient signals and thus benefitted from practice with context monitoring. However, our targeted context-monitoring practice without motoric stopping was more effective. Furthermore, better modal response inhibition in the Simultaneous-Monitoring condition than the Context-Monitoring condition demonstrates that parametric manipulation of context-monitoring demands using otherwise equivalent stimuli shapes subsequent response inhibition.

Of note, after practice with stopping, and even more so, monitoring, advantages in the leading edge of the SSRT distribution (μ estimates) were accompanied by elevated tails (τ estimates). Thus, practice yields faster modal response inhibition, increasing the large proportion of trials that fall within the adult range of SSRTs (roughly 100-300 ms); however, it is also associated with an increase in the small proportion of extremely long SSRTs (>500 ms), which may reflect occasional neglect of the stopping goal (e.g., due to increased fatigue), especially if the cue has become associated with going again. Such tradeoffs could only be revealed by recent methodological advances in estimating SSRT (Matzke et al., 2012).

These findings reveal that monitoring for relevant contextual cues is critical to developing inhibitory control and suggest promising new directions for interventions. Previous attempts to train inhibition during childhood have shown limited success (reviewed in Diamond & Lee, 2011), but did not target context monitoring, nor assess effects on the entire distribution of SSRTs. Practice monitoring enhanced response inhibition, despite the mismatched motor demands between training and test. This

The practice of stopping helps children to stop mismatch isolated and tested the contributions of context monitoring, but would not be necessary for real-world applications; children could practice monitoring for relevant contextual cues without learning an unhelpful response to them.

These broad theoretical and practical implications also motivate important next steps. Future work should determine whether context monitoring also contributes to response inhibition earlier in typical development and disinhibitory disorders, whether and how improvements in context monitoring drive developments in response inhibition, and how generalizable context-monitoring interventions are across situations and populations. Such work will inform an understanding of typical inhibitory control failures (like children hitting friends and adults checking phones), associated life outcomes, and clinical disorders linked to impaired inhibitory control.

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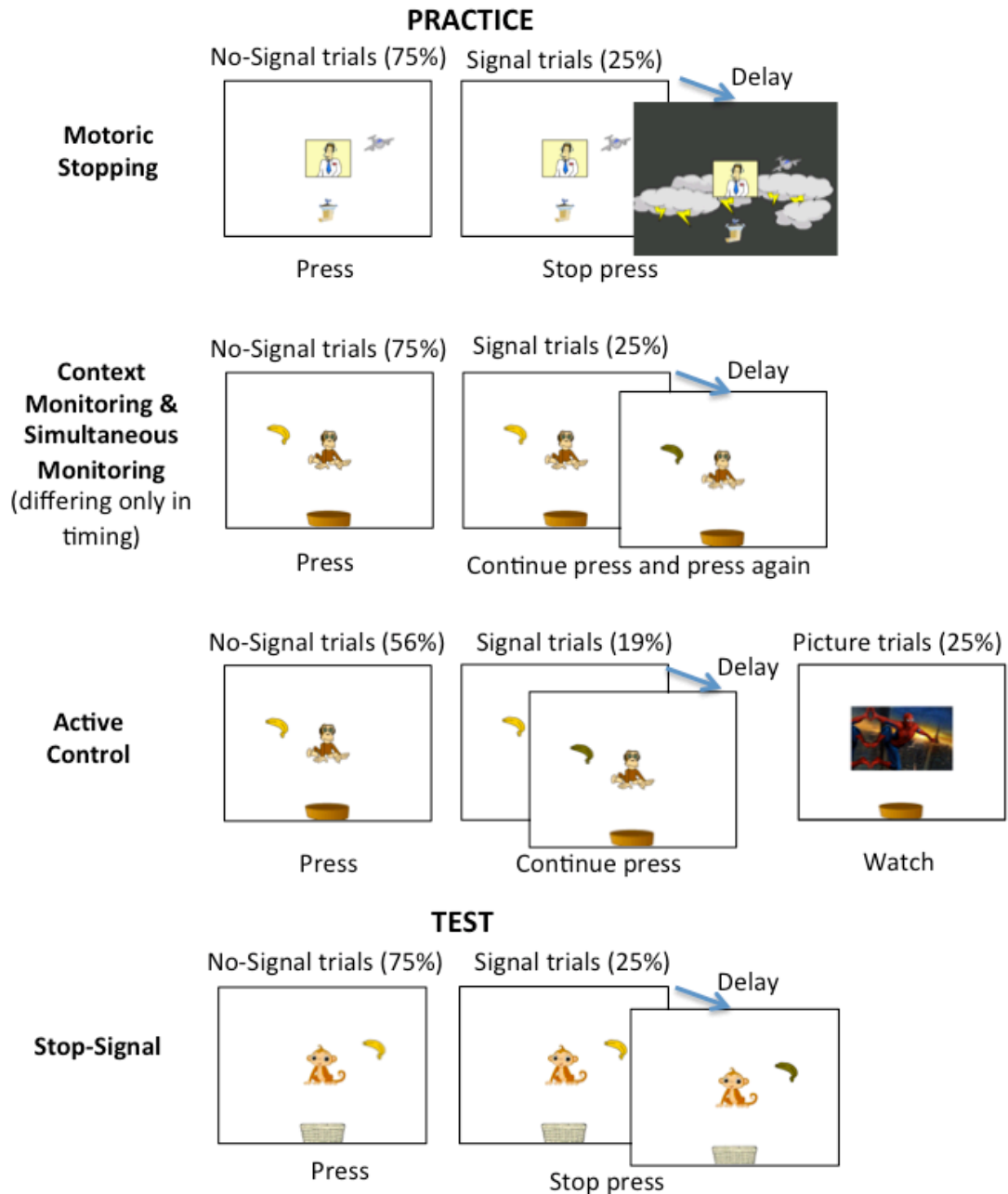
doi:10.1016/j.dr.2012.07.001

Figure 1. Practice conditions and Stop-Signal test. Children were instructed to press the same side as the target. Signal trials involved a change in target color or clouds/thunder, indicating that children had to stop their response (Motoric-Stopping, and test), continue to press and then press again (Context- and Simultaneous-Monitoring), or simply complete the initial press (Active Control).
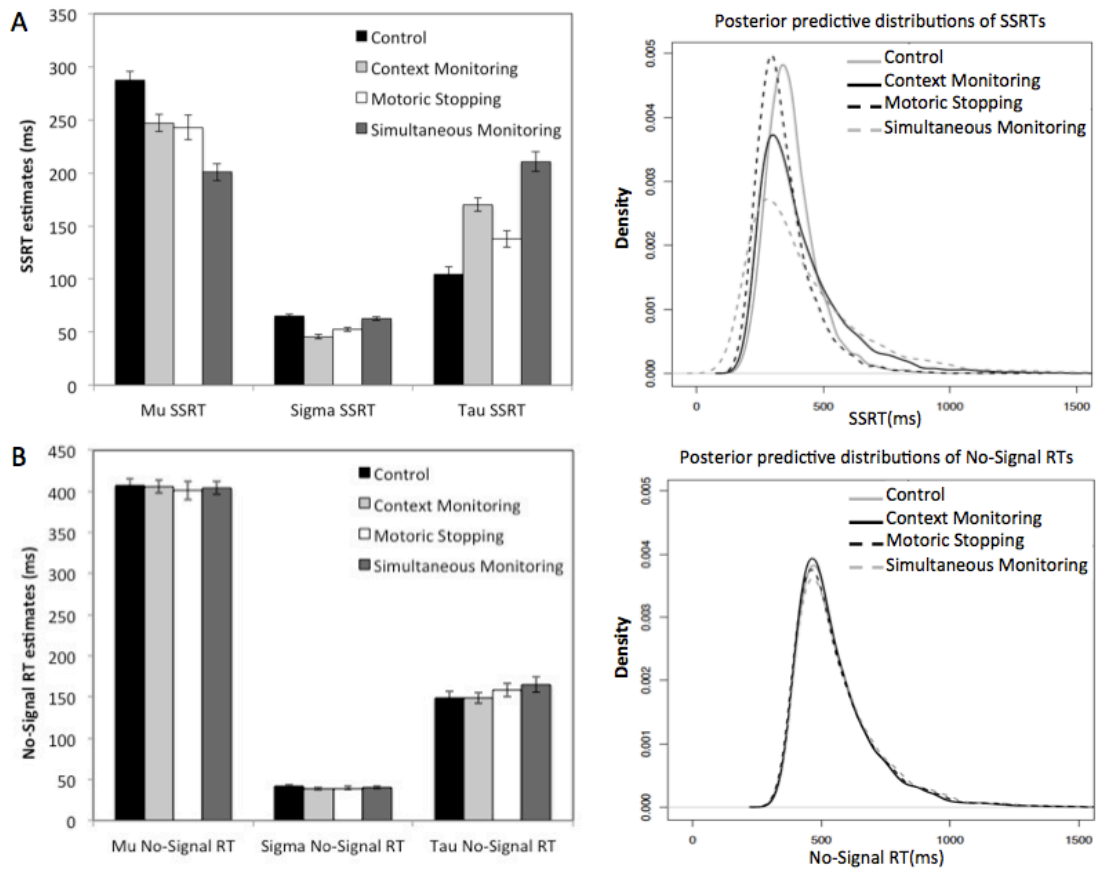
Figure 2. Performance in the Stop-Signal task (test) as a function of the practice condition. Context-Monitoring ($N = 27$) or Motoric-Stopping practice ($N = 29$) yielded better response inhibition (faster modal SSRTs, μ) in the Stop-Signal task, relative to controls ($N = 32$), with best performance after Simultaneous Monitoring practice ($N = 32$). Across conditions, SSRT distributions varied in shape (A), whereas distributions of No-Signal reaction times largely overlapped (B).
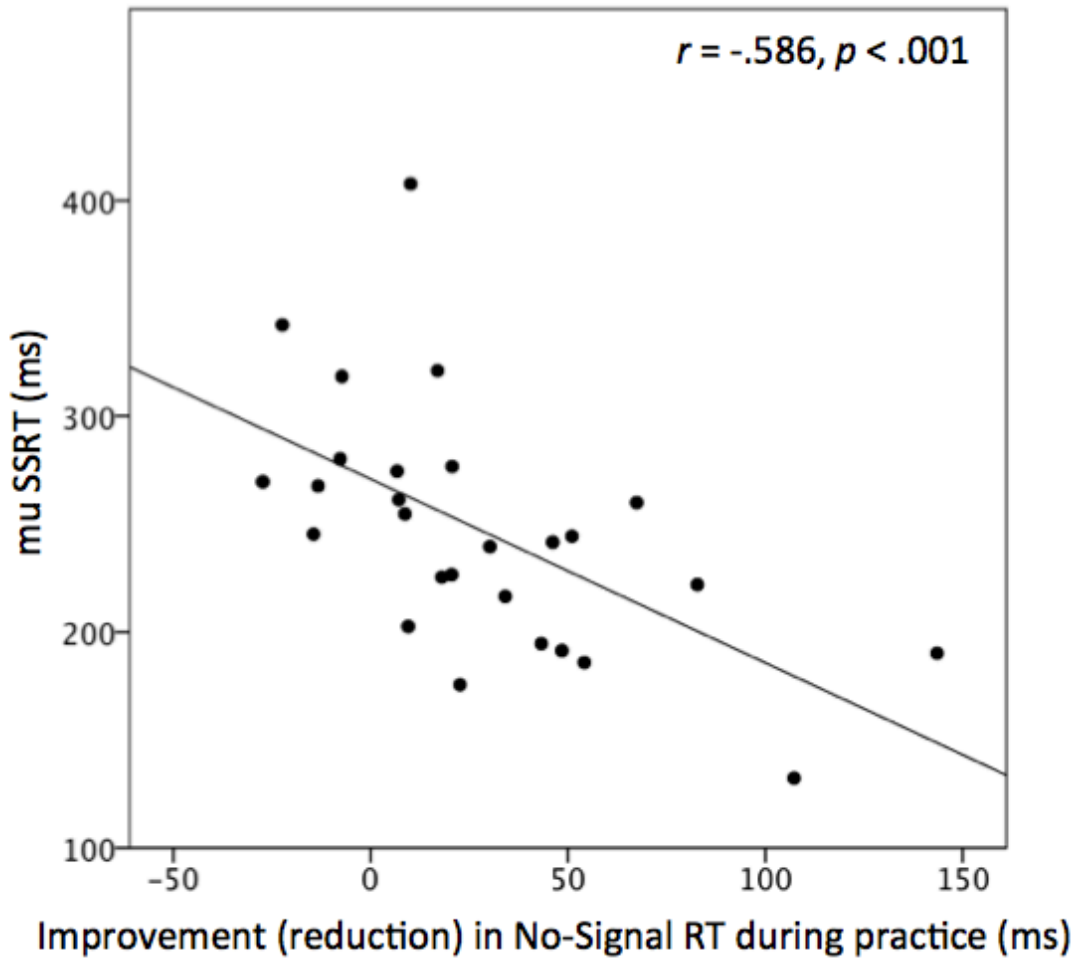
Figure 3. Improvement during Context-Monitoring practice predicted modal SSRT

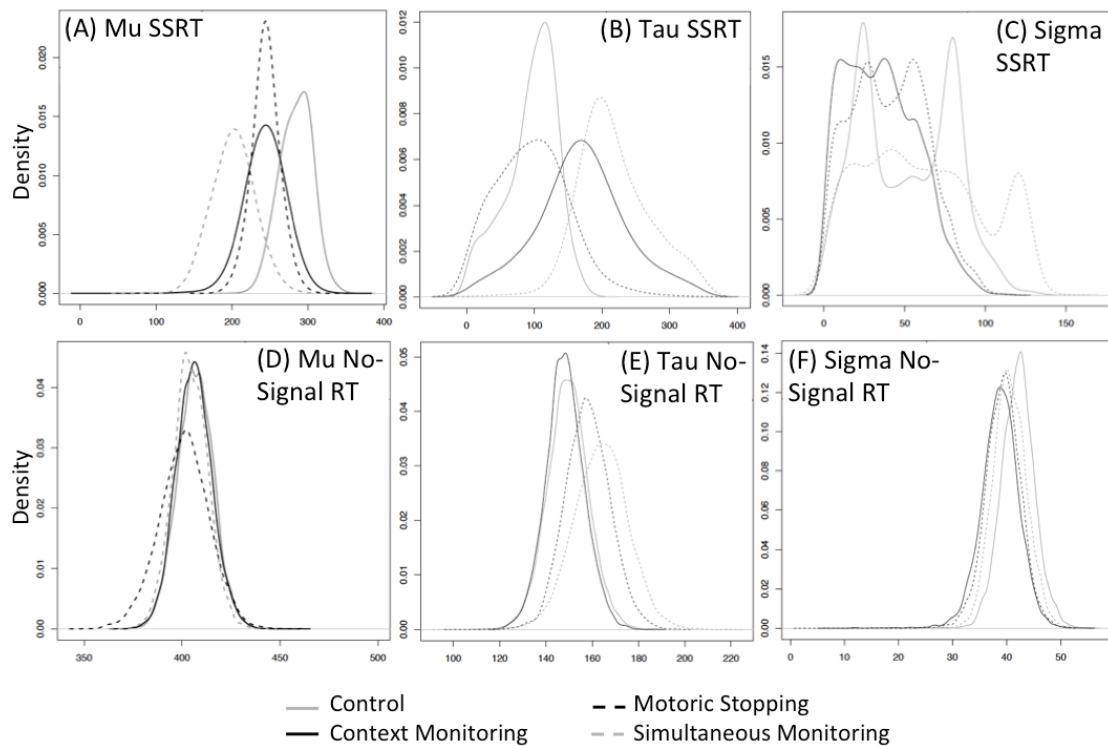(B). Error bars indicate standard errors.

Figure S1. Posterior density plots. **A.** Differences in the mode of SSRT were evident in the posterior density plots across conditions, and replicated the frequentist analyses derived from these estimates presented in the main text. The simultaneous monitoring condition ($N = 32$) was associated with the fastest modal SSRT, followed by the approximately equal modal SSRT observed in the context-monitoring and stopping conditions ($N = 27$ and $N = 29$, respectively), which were in turn followed by the comparatively slow modal SSRT observed in the control condition ($N = 32$). **B.** Differences in the exponential skew of SSRT were evident in the posterior density plots across conditions, and again largely replicated the frequentist analyses derived from these estimates presented in the main text. The simultaneous monitoring condition was associated with the highest skew to SSRT, followed by the Context-Monitoring conditions, which was in turn followed by the comparatively small skew observed in the Stopping and Control conditions. **C.** No differences between conditions were evidence in the posterior density plot for σ SSRT. **D.** No differences between conditions were evident in the posterior density plot for μ No-Signal RT. **E.**

No differences between conditions were evident in the posterior density plot for τ No-Signal RT. **F.** No differences between conditions were evident in the posterior density plot for σ No-Signal RT.

Table 1

Performance improved during practice in Context Monitoring, Motoric Stopping, and Simultaneous Monitoring conditions. Standard deviations are presented in parentheses. Significant effects are bolded.

	Part 1 Blocks 1-2	Part 2 Blocks 3-4	Part 3 Blocks 5-6	ANOVA
Context-Monitoring (Exp. 1)				
No-Signal Accuracy	.90 (.07)	.92 (.05)	.91 (.06)	$F(2, 52) = 2.60$, $p = .084$, $\eta^2_p = .091$
No-Signal reaction time	**527 ms (81)**	**510 ms (70)**	**499 ms (65)**	$F(2, 52) = 6.28$, $p = .004$, $\eta^2_p = .194$
Signal Accuracy	**.47 (.23)**	**.56 (.25)**	**.57 (.22)**	$F(2, 52) = 10.66$, $p < .001$, $\eta^2_p = .291$
Signal 1st press latency	**604 ms (153)**	**581 ms (154)**	**557 ms (115)**	$F(2, 52) = 5.10$, $p = .009$, $\eta^2_p = .164$
Signal 2nd press latency	929 ms (150)	925 ms (161)	914 ms (123)	$F(2, 52) = .58$, $p = .560$, $\eta^2_p = .022$
Motoric Stopping (Exp. 1)				
No-Signal Accuracy	.82 (.15)	.83 (.15)	.84 (.15)	$F(2, 56) = 1.47$, $p = .237$, $\eta^2_p = .050$
No-Signal reaction time	**544 ms (82)**	**535 ms (76)**	**524 ms (73)**	$F(2, 56) = 8.66$, $p = .001$, $\eta^2_p = .236$
Signal Accuracy	.73 (.17)	.73 (.15)	.73 (.18)	$F(2, 56) = .01$, $p = .983$, $\eta^2_p = .001$
Control (Exp. 1)				
No-Signal Accuracy	.91 (.09)	.91 (.07)	.91 (.07)	$F(2, 62) = .18$, $p = .831$, $\eta^2_p = .006$
No-Signal reaction time	510 ms (71)	514 ms (71)	508 ms (71)	$F(2, 62) = .82$, $p = .443$, $\eta^2_p = .026$
Signal Accuracy	.91 (.07)	.91 (.07)	.91 (.09)	$F(2, 62) = .03$, $p = .966$, $\eta^2_p = .001$
Signal reaction time	510 ms (72)	514 ms (71)	520 ms (80)	$F(2, 62) = .89$, $p = .415$, $\eta^2_p = .028$
Simultaneous Monitoring (Exp. 2)				
No-Signal Accuracy	**.88 (.09)**	**.92 (.05)**	**.92 (.04)**	$F(2, 62) = 9.50$, $p < .001$, $\eta^2_p = .235$
No-Signal reaction time	**519 ms (76)**	**501 ms (64)**	**485 ms (61)**	$F(2, 62) = 17.08$, $p < .001$, $\eta^2_p = .355$
Signal Accuracy	**.47 (.24)**	**.56 (.23)**	**.66 (.19)**	$F(2, 62) = 18.41$, $p < .001$, $\eta^2_p = .373$
Signal 1st press latency	**564 ms (108)**	**529 ms (94)**	**498 ms (79)**	$F(2, 62) = 15.92$, $p < .001$, $\eta^2_p = .339$
Signal 2nd press latency	**906 ms (134)**	**871 ms (124)**	**845 ms (119)**	$F(2, 62) = 12.85$, $p < .001$, $\eta^2_p = .293$

Supplementary Information

Bayesian Analysis

Estimation was performed hierarchically using Ex-Gaussian Estimation of Stop Signal (BEESTS) v1 (http://dora.erbe-matzke.com/software/BEESTS-1.0.zip), with a separate model for each condition. For each run of the model (1 per condition), 3 Markov chains were burnt-in for 5000 iterations, and mean posterior values for each parameter were saved for 15000 iterations (after thinning by 5). The chains mixed rapidly, as evident in posterior trace plots for each group-level parameter (see also posterior density plots in Supporting Figure 1). Gelman-Rubin Rhat convergence diagnostics were close to 1 for all parameters estimated in each model. The model yielded deviances of 46655, 43375, 50923 and 51875 for the Motoric-Stopping, Context-Monitoring, Control, and Simultaneous-Monitoring conditions, respectively.

To complement the frequentist analysis of the subject-specific posterior means from BEESTS presented in the main text, we also conducted a simple Bayesian analysis of the group posterior estimates from BEESTS. For each parameter we calculated a posterior density plot of its difference at each iteration of each chain across each pair of conditions; we then calculated the proportion of this density plot that lay entirely on one side of zero. This proportion represents a simple estimate of the rational belief that, given the data we observed and a uniform prior, the true value of the difference between conditions lies on one side of zero. (Although Bayesian analyses can offer support in favor of "null" effects, below we focus on testing hypotheses regarding differences across conditions).

With respect to μ SSRT (Supporting Figure 1A), the model indicates support for extremely strong beliefs of higher μ SSRT in Control condition than in any other

The practice of stopping helps children to stop

condition (including the Simultaneous-Monitoring, Stopping, and Context Monitoring

conditions, with posterior densities of 100%, 95%, and 92% lying on one side of zero,

respectively). Whereas there was strong evidence in support of no difference between

the Stopping and Context-Monitoring conditions in terms of μ SSRT (mean density of

difference lay only 54% on one side of zero), the model does support a strong belief

that these conditions both showed higher μ SSRT than the Simultaneous Monitoring

condition (94 and 92% posterior density outside zero for differences with Stopping

and Context-Monitoring, respectively).

With respect to τ SSRT (as shown in Fig. S1B), strong evidence was found

only for a few differences. First, the largest τ SSRT was in the simultaneous condition

(90%, 95%, and 78% of the posterior densities lie outside zero as compared with

control, stopping practice; and context monitoring practice, respectively). Somewhat

weaker evidence indicates that τ SSRT was larger in the context-monitoring condition

than in the control (84%) and stopping (79%) conditions. By contrast, comparatively

strong evidence for null effects of our experimental manipulations were observed on

the other measures, given the largely overlapping posterior densities for those

parameters (as illustrated in panels C-F of Fig. S1).