Automatic effects of No-Go Instructions

Baptist Liefooghe

Jasper Degryse

Marijke Theeuwes

Ghent University

Author note:

This research was supported by grant BOF09/01M00209 of Ghent University. The authors are indebted to Jan De Houwer and Frederick Verbruggen for their valuable comments on this project.
Correspondence concerning this paper should be addressed to Baptist Liefooghe, Department of Experimental-Clinical and Health Psychology, Ghent University, Henri Dunantlaan 2, B-9000 Ghent (Belgium), Email: baptist.liefooghe@ugent.be, Phone: +32-(0)9-264.64.91.43.

Abstract

Previous research indicated that stimulus-response mappings that have been instructed but never applied overtly before can lead to automatic response biases when they are irrelevant. In the present study, we investigated whether the same applies to No-Go instructions, which relate a stimulus to a No-Go response. The results of two experiments suggest that a No-Go instruction that has never been practiced overtly before can automatically bias responding when it is irrelevant. In addition, the automatic effect of a No-Go instruction was of similar size as the automatic effect of a Go instruction. Finally, the automatic effect of an unpracticed No-Go instruction tended to be larger than the automatic effect of an overtly practiced No-Go instruction. We propose that (a) associations between a stimulus and the requirement to stop can be formed on the basis of instructions and this without overt practice; (b) these associations may be functionally equivalent to associations formed on the basis of Go instructions; and (c) that overtly practiced No-Go instructions and unpracticed No-Go instructions are represented in different formats.

Automatic effects of No-Go Instructions

Instructions play an important role in daily life. Instructions specify response rules and the conditions in which these apply. In recent years, research has emphasized the importance of instructions and an increasing number of studies demonstrate that the power of instructions is far stronger than previously thought. Research has indicated that instructions can induce (e.g., Liefooghe, Wenke, & De Houwer, 2012; Meiran, Pereg, Kessler, Cole, & Braver, 2015a), modulate (e.g., Cohen, Bayer, Jaudas, & Gollwitzer, 2008), and even eliminate (e.g., Bardi, Bundt, Notebaert, & Brass, in press; Theeuwes, Liefooghe, & De Houwer, 2014) automatic effects on behavior. At the present time, research has primarily focused on instructions specifying that a particular response has to be made or a response strategy has to be adopted (e.g., press fast) when a particular condition is met (e.g., the presentation of a stimulus). Nevertheless, a substantial part of daily-life instructions do not include the requirement to respond, but the requirement not to respond. To our knowledge the impact of these instructions has not been investigated so far. Accordingly, the present study investigated whether No-Go instructions, that have not been applied overtly before, can also bias behavior automatically.

No-Go instructions are typically used in the Go/No-Go task (Donders, 1868/1969). In this task, instructions relate one stimulus to a Go response and another stimulus to a No-Go response. The proportion of false hits on No-Go trials is considered as an index of the ability to inhibit the tendency to respond. Recent studies have suggested that No-Go responses are completed through automatized control processes (e.g., Verbruggen & Logan, 2008). Verbruggen and Logan (2008) used a Go/No-Go task in which participants executed a Go or a No-Go response, either to a living or a nonliving object. After a practice phase, the Go/No-Go requirements switched. For instance, if living objects required No-Go responses in the practice phase, living objects required Go responses in the test phase. The test phase also included new stimuli that were not presented in the practice phase. Verbruggen and Logan (2008) observed that Go responses to stimuli, which required a No-Go response in the practice phase, were slower compared to Go responses to new stimuli. In a follow-up experiment, such slowing was observed when the Go and No-Go responses in the test phase and the practice phase had to be applied to different stimulus features, for instance, size (e.g., small = > Go; large => No-Go) in the practice phase and lividness (e.g., living => Go; non-living => No-Go) in the test phase. Based on these findings, Verbruggen and Logan (2008) have suggested that associations between a stimulus and a No-Go response are established on the basis of practice and that such associations can be retrieved automatically later on.

The present study investigated whether effects similar to the effects reported by Verbruggen and Logan (2008) could be obtained for No-Go instructions that were never practiced overtly before. To this end, we used a procedure introduced by Liefooghe, Wenke, De Houwer (2012, see also Liefooghe, De Houwer, & Wenke, 2013). In the original procedure of Liefooghe and colleagues, participants were presented with different runs of trials on which two tasks could be performed: the inducer task and the diagnostic task. In each run, both tasks shared the same stimuli and responses. Furthermore, each run used a different pair of stimuli and stimuli were never re-used across different runs. At the beginning of each run, participants received two novel arbitrary S-R mappings of the inducer task. Each S-R mapping assigned the identity of a stimulus to a left or a right response (e.g. If ‘X’, press left; if ‘Y’, press right). Before executing the inducer task, several trials of the diagnostic task had to be performed. In the diagnostic task, participants decided whether a stimulus was presented in italic or upright, again by pressing a left or a right response-key (e.g. upright, press left; *italic*, press right). Liefooghe et al. (2012, 2013) observed that RTs in the diagnostic task were shorter for responses that matched the instructed S-R mappings of the inducer task (‘X’ presented upright or ‘*Y*’ presented in *italic*) than for responses that did not match the instructed S-R mappings of the inducer task (‘Y’ presented upright or ‘*X*’ presented in *italic*). Given that (a) the diagnostic task was performed immediately after the presentation of the instructions of the inducer task, thus prior to the overt application of these instructions and (b) the inducer task comprised novel S-R mappings on each run and stimuli were never re-used across runs, the congruency effect observed in the diagnostic task was supposedly based on the instructed S-R mappings of the inducer task. Liefooghe et al. (2012) have proposed that during the diagnostic task, task-irrelevant responses are activated on the basis of the S-

R mappings of the inducer task (see Everaert, Theeuwes, Liefooghe, & De Houwer, 2014; Meiran, Pereg, Kessler, Cole, & Braver, 2015b for electrophysiological evidence in support of this hypothesis).

In the present study, the procedure of Liefooghe et al. (2012) was adapted so that we could investigate the extent by which No-Go instructions bias performance automatically. The first type of run, the *Instructed Go/No-Go run* was the most critical. At the beginning of Instructed Go/No-Go runs, participants were presented with a new pair of S-R mappings of the inducer task. One S-R mapping related the identity of a stimulus to a left or a right response (*control mapping*, e.g., “if Q, press left”). The other S-R mapping related the identity of a stimulus to a No-Go response (*test mapping*, e.g., “if E, do not press). Immediately after the presentation of the S-R mappings of the inducer task, the diagnostic task was presented. As in the original procedure of Liefooghe et al. (2012), the diagnostic task required a left or a right key-press in response to the orientation of the stimulus (upright or italic). Finally, after a number of trials of the diagnostic task, the inducer task had to be executed for four trials. In the Instructed Go/No-Go runs, the instructions of the inducer task could thus not be practiced overtly before the diagnostic task. Based on the findings of Verbruggen and Logan (2008), the following prediction was be made: If encoding No-Go instructions is sufficient to automatically bias responding, then longer RTs are expected in the diagnostic task for stimuli assigned to the test mapping of the inducer task than for stimuli assigned to the control mapping of the inducer task. Alternatively, if encoding No-Go instructions is not sufficient to bias performance automatically, then RTs in the diagnostic task will not differ between stimuli assigned to a test mapping and stimuli assigned to a control mapping. The latter case is, however, problematic because the possibility remains that No-Go instructions can bias performance automatically, but that this effect cannot be captured by our procedure. Accordingly, two other types of runs were constructed, which served as additional controls in case we did not observe any difference between the control mappings and the test mappings of the instructed Go/No-Go runs.

The first type of control run, the *Practiced Go/No-Go run*, was created to test whether the basic findings of Verbruggen and Logan (2008) could be replicated in the procedure developed by

Liefooghe et al. (2012). These runs were similar to the Instructed Go/No-Go runs, but the S-R mappings of the inducer task were now practiced overtly prior to the diagnostic task. On each run, participants (a) first received the test mapping (e.g. “if E, do not press”) and the control mapping (e.g. “if Q, press left”) of the inducer task; (b) practiced these mappings on a number of trials of the inducer task; (c) performed a number of trials of the diagnostic task; and (d) performed the inducer task for four trials. Practiced Go/No-Go runs are conceptually similar to the procedure used by Verbruggen and Logan (2008). If their findings generalize to Practiced Go/No-Go runs, stimuli in the diagnostic task that are assigned to the test mapping of the inducer task are expected elicit slower responses than stimuli assigned to the control mapping of the inducer task. On the one hand, if no automatic effects of No-Go instructions are observed in the Instructed Go/No-Go runs, the results of the Practiced Go/No-Go can indicate if our procedure allows for the measurement of automatic effects of practiced Go/No-Go instructions. On the other hand, if automatic effects of No-Go instructions are observed in the instructed Go/No-Go runs, the comparison with the effects observed in the practiced Go/No-Go runs is helpful to assess how practice modulates the effect of No-Go instructions.

The second type of control run was the *instructed spacebar run*. In the original procedure of Liefooghe et al. (2012, 2013), the inducer and the diagnostic task shared the same pair of left-right responses. In the Instructed Go/No-Go runs, the control mapping (e.g. “If Q, press left”) shares a response with the diagnostic task, whereas the test mapping (e.g., “if E, do not press”) refers to an action that is irrelevant for the diagnostic task, namely not responding. Accordingly, the absence of an automatic effect of No-Go instructions in the instructed Go/No-Go runs could result from the fact that automatic effects of instructions are restricted to situations in which the inducer and the diagnostic task share the same set of responses. As a control for this potential limitation, the instructed spacebar runs were used. These runs were completely similar to the instructed Go/No-Go runs, except that the test mappings required participants to press the spacebar (e.g. “If E, press the spacebar”). As for the No-Go response in the Instructed Go/No-Go runs, pressing the spacebar is completely irrelevant for the diagnostic task. However, it constitutes a Go response. If no effects are observed in the Instructed

Go/No-Go runs, Instructed Spacebar Runs indicate whether the absence of such an effect is related to the fact that No-Go instructions cannot bias responding or to the fact that instruction-based effects are confined to situations in which the inducer task and the diagnostic task share the same responses. In addition, as we will discuss later on, the comparison between instructed Go/No-Go runs and instructed spacebar runs also offers some insights in the processes underlying the automatic effect of instructed No-Go mappings.

Experiment 1

The primary aim of Experiment 1 was to investigate whether No-Go instructions that have not been practiced overtly before can bias performance when being irrelevant. To this end, participants were presented with: Practiced Go/No-Go runs, Instructed Go/No-Go runs, and Instructed Spacebar runs. The critical result is the difference between test mapping trials and control mapping trials in the diagnostic task of the Instructed Go/No-Go runs. In each run, the control mapping assigns a stimulus to either a left or a right response. In the diagnostic task, two trial types can be discerned for stimuli assigned to the control mapping of the inducer task: trials on which the response in the diagnostic task matches the response denoted by the control mapping of the inducer task (i.e., control mapping congruent trial) and trials on which both responses do not match (i.e., control mapping incongruent trial). In view of the potential difference between both types of trials (see supra), the diagnostic task was devised such that one third of the trials is control mapping congruent, one third is control mapping incongruent and one third is associated with the test mapping of the inducer task. An overview of the different run types and trial types that were used in Experiment 1 is provided in Table 1.

Method

Participants and Design

Thirty-one students participated in Experiment 1. Twenty-nine participants received a €6 payment, two participated without payment. All subjects were required to have normal or corrected eyesight. Participants were naive to the purpose of the experiment.

Materials

In line with the original procedure of Liefooghe et al. (2012), each run used a different pair of stimuli. These pairs of stimuli were randomly drawn from a list of 56 stimuli, which consisted of letters, numbers, punctuation marks and symbols (e.g., R, 3, &, I). For each participant, 28 pairs of stimuli were randomly created. One pair was randomly assigned to the practice block. This pair of stimuli was re-used in the three runs of the practice block. The remaining 27 pairs of stimuli were randomly assigned to the three experimental blocks. Hence, 9 pairs of stimuli were used in each experimental block, with 3 pairs of stimuli assigned to each run type.

A schematic overview of the different types of runs is presented in Figure 1. Each run consisted of the inducer task and the diagnostic task. Both tasks used the same pair of stimuli. The relevant stimulus feature in the inducer task was the identity of the stimulus. The relevant stimulus feature in the diagnostic task was the orientation of the stimulus (upright or italic). The color of the stimulus indicated which task to perform. If the stimulus was green, the inducer task had to be performed. If the stimulus was black, the diagnostic task had to be performed. Stimuli were presented on a white background. Responses were registered by using an AZERTY keyboard. The response keys of the inducer task were the A-key (left response), P-key (right response), and the spacebar. The response keys of the diagnostic task were the A-key (left response) and the P-key (right response). The spacebar was never used in the diagnostic task. Responses on the left and right keys were made with the index fingers of the corresponding hand. For the spacebar response, participants had to press with their two thumbs simultaneously. In the inducer task, novel S-R mappings were instructed on each run. For the diagnostic task, the response mappings were fixed across the whole experiment (e.g., "if upright, press left; if italic, press right") and counterbalanced across subjects.

At the start of each run, the new S-R mappings of the inducer task were presented around the screen center. One S-R mapping was presented approximately 1 cm above the screen center and one S-R mapping was presented approximately 1 cm below the screen center. The position of the S-R mapping was determined randomly, so that the instructions referring to a certain response could be presented either above or below the screen center. In the Instructed Go/No-Go runs, one S-R mapping (the control mapping) assigned a stimulus to a right or a left response (e .g., "if Q, press left") and the other mapping (test mapping) assigned a stimulus to the requirement not to respond (e.g., "if E, do not press"). The instructions of the inducer task were immediately followed by either 6, 12 or 24 trials of the diagnostic task. The number of trials of the diagnostic task varied in order to make the onset of the inducer task relatively unpredictable. This manipulation was intended to encourage participants to actively maintain the instructed S-R mappings of the inducer task (see Liefooghe et al., 2012). After the last trial of the diagnostic task, the inducer task had to be performed for 4 trials (i.e., two trials per mapping).

The Practiced Go/No-Go runs were similar to the Instructed Go/No-Go runs, except that that the S-R mappings of the inducer task were first followed by a training phase consisting of 40 trials in which the mappings of the inducer task were practiced (20 trials for the control mapping; 20 trials for the test mapping), before the diagnostic task started. The Instructed Spacebar runs were also similar to the Instructed Go/No-Go runs, except that the test mapping required participants to press the spacebar in response to a particular stimulus.

Stimuli and instructed S-R mappings were presented in font type Arial with font size 36 (visual angle of 6.87") in the center of the monitor.

Procedure

Participants were tested in groups of two or three by using personal computers attached to a 17-inch color monitor. The experiment was programmed by using the Tscope library for C/C++ (Stevens, Lammertyn, Verbruggen, & Vandierendonck, 2006). At the start of the experiment, the overall instructions were presented. Experiment 1 consisted of a practice block and three experimental blocks. In each experimental block, participants were presented with three Instructed Go/No-Go runs, three Practiced Go/No-Go runs and three Instructed Spacebar runs. For each type of run, one of the runs comprised 6 trials of the diagnostic task, one comprised 12 trials of the diagnostic task and one comprised 24 trials of the diagnostic task. The practice block consisted of three runs, one of each type. For each run of the practice block, the number of trials of the diagnostic task could be 6, 12, or 24. The assignment of the number of diagnostic trials to each type of run was determined randomly. In the practice block as well as in the experimental blocks, the different types of runs were presented in a random order.

Each run started with the presentation of a fixation cross for 1500ms, followed by the S-R mappings of the inducer task. The S-R mappings were presented for maximally 20 seconds or until participants pressed the spacebar. In the Instructed Spacebar runs and Instructed Go/No-Go runs, the first stimulus of the diagnostic task appeared 750ms after the offset of the instructions of the inducer task. Stimuli remained on screen for maximally 2000ms. After 6, 12, or 24 trials of the diagnostic task, the inducer task started. The inducer task used the same time parameters as the diagnostic task. Stimuli in the inducer task were printed in green. In the Practiced Go/No-Go runs, participants first performed the inducer task for 40 trials before the diagnostic task started. The Practiced Go/No-Go runs also ended with the presentation of 4 trials of the inducer task. Runs were separated by a 1500ms interval. Incorrect responses or unwarranted go-responses, were followed by error feedback, namely a red screen flash for 200ms. The experiment lasted for approximately 45 minutes.

Results

Diagnostic task

Practice blocks were not included in the analyses, leaving 378 trials of the diagnostic task for analysis (i.e., 42 per cell). For RTs, only correct trials were considered, leading to the removal of 6.62% of the total number of trials. Next, per participant, trials with RTs larger than 2.5 standard deviation above each cell mean, were considered as outliers and excluded. This outlier analysis led to the removal of 3.21 % of the total number of correct trials. RTs and PEs were analyzed separately using a 3 (Run Type: Instructed Spacebar runs, Instructed Go/No-Go runs, Practiced Go/No-Go runs) by 3 (Trial Type: control mapping congruent, control mapping incongruent, test mapping) repeated measures ANOVA. For all analyses in the present study, an alpha-level of .05 was used. Means and standard deviations of each cell of the design are presented in Table 2.

For the RTs, the main effect of Run Type was significant, $F(2,60) = 42.56$, $MSE = 1939$, $p<.001$,

η^2_p = .59. RTs were longer in Instructed Spacebar runs (M = 624, *SD* = 99) compared to Instructed Go/No-Go runs (*M*=598, *SD*=90), *t*(30)=4.11, *p*<.001, r^2=.36, and RTs were longer in Instructed Go/No-Go runs than in Practiced Go/No-Go runs *(M=* 564, *SD=* 88), *t*(30) = 5.29, *p*<.001, r^2= .48. The main effect of Trial Type was also significant, *F*(2,60) = 60.00, *MSE* = 1590, *p*<.001, η^2_p = .67. RTs were marginally faster on control mapping congruent trials (*M* =572, *SD* =93) than on control mapping incongruent trials (*M = 582, SD* =90), *t*(30) = 2.01, *p*=.053*,* r^2= .12. On control mapping congruent trials the mapping of the inducer task refers to a left or a right response (e.g., "If Q, press left"), which matches with the response required by the diagnostic task (i.e., left). On control mapping incongruent trials, the response required by the diagnostic task does not match with the response denoted by the mapping of the inducer task (i.e., right). This difference thus slightly modulated RTs. RTs on test mapping trials (*M* = 632, *SD* = 93) were longer compared to control mapping congruent trials, *t*(30) = 9.25, *p*<.001, r^2= .74, and control mapping incongruent trials, *t*(30) = 8.32, *p*<.001, r^2= .70. On test mapping trials, the mapping of the inducer task refers to a No-Go response (e.g., "if E, do not press") in Instructed Go/No-Go runs and to a Go response (e.g., "if Q, press spacebar") in Instructed Spacebar runs.

A trend toward an interaction between Run Type and Trial Type was observed, *F*(4,120) = 2.11, *MSE*= 1409, *p*=.084, η^2_p = .07. We are aware that splitting out such marginal interaction should be done with reasonable caution. Nevertheless, we explored the presence of potential differences between the Instructed Go/No-Go runs and the Instructed Spacebar runs, on the one hand, and the Instructed Go/No-Go runs and Practiced Go/No-Go runs, on the other hand. First, we focused on the difference between control mapping congruent and control mapping incongruent trials in the three types of runs. To this end, we did not consider the test mapping trials and conducted a 2 (control mapping congruent vs. control mapping incongruent trials) by 3 (Run Type) repeated measures ANOVA. The interaction between both main effects was not significant, *F*<1. Second, we focused on the difference between control mapping incongruent trials and test mapping trials. A two-way ANOVA was now conducted in which the control mapping congruent trials were not considered. Trial Type (control mapping incongruent vs. test mapping) and Run Type interacted marginally: $F(2,60) = 2.92$, $MSE = 1776$, $p=.062$, $\eta^2_p = .09$. Further analyses indicated that the difference between control mapping incongruent trials and test mapping trials was similar for Instructed Spacebar runs and Instructed Go/No-Go runs, $F<1$. In contrast, the difference between control mapping incongruent trials and test mapping trials was marginally smaller in the Practiced Go/No-Go runs than in the Instructed Go/No-Go runs, $F(1,30)= 3.80$, $MSE = 2435$, $p=.061$, $\eta^2_p = .11$. Finally, we considered the difference between control mapping congruent trials and test mapping trials. The interaction between Trial Type (control mapping congruent vs. test mapping) and Run Type was on the verge of significance: $F(2,60) = 3.01$, $MSE = 1025$, $p=.057$, $\eta^2_p = .09$. Additional analyses indicated that the difference between control mapping congruent trials and test mapping trials was similar for Instructed Spacebar runs and Instructed Go/No-Go runs, $F<1$. In contrast, the difference between control mapping congruent trials and test mapping trials was slightly smaller in the Practiced Go/No-Go runs than in the Instructed Go/No-Go runs, $F(1,30)= 3.39$, $MSE= 1150$, $p=.075$, $\eta^2_p = .11$.

For the PEs, the effect of Run Type was significant, $F(2,60) = 3.69$, $MSE=.002623$, $p<.05$, $\eta^2_p = .11$. The difference between PEs in the Instructed Spacebar runs ($M = .08$, $SD = .05$) and Instructed Go/No-Go runs ($M = .07$, $SD = .04$) was not significant, $t<1$. PEs in the Practiced Go/No-Go runs ($M = .05$, $SD = .03$) were significantly lower compared to PEs in the Instructed Spacebar runs, $t(30) = 2.29$, $p<.05$, $r^2 = .15$, but only marginally lower compared to the PEs in the Instructed Go/No-Go runs, $t(30) = 1.92$, $p=.064$, $r^2 = .11$. The main effect of Trial Type was also significant, $F(2,60) = 12.06$, $MSE = .001948$, $p<.001$, $\eta^2_p = .29$. PEs were lower for control mapping congruent trials ($M = .05$, $SD = .03$) compared to control mapping incongruent trials ($M = .07$, $SD = .04$), $t(30) = 4.27$, $p<.001$, $r^2 = .38$ and test mapping trials ($M = .07$, $SD = .05$), $t(30) = 4.67$, $p<.001$, $r^2 = .42$. There was no significant difference between control mapping incongruent trials and test mapping trials, $t < 1$. The two-way interaction was not significant, $F< 1$.

Inducer task

In a first analysis, we focused on trials with stimuli that were assigned to the control mapping of the inducer task. Control mappings relate a stimulus to a right or a left response and are present in all three types of runs. As such, comparable measures of performance were obtained. For the RTs, incorrect trials (6.1% of the total number of trials) and trials with RTs 2.5 standard deviation above each cell mean of each participant were considered as outliers (1.7% of the total number of correct trials). A one-way repeated measures ANOVA with Run Type as a factor was performed on the RTs and the PEs separately. For RTs, the main effect of Run Type was significant, $F(2,60) = 3.67$, $MSE = 9287$, $p<.05$, $\eta^2_p = .11$. The difference between Instructed Spacebar runs ($M = 657$, $SD = 105$) and Practiced Go/No-Go runs ($M = 592$, $SD = 127$) was significant, $t(30) = 2.51$, $p<.05$, $r^2 = .17$. Instructed Go/No-Go runs ($M = 617$, $SD = 115$) did not differ significantly from the Instructed Spacebar runs, $t(30) = 1.56$, $p=.13$, $r^2 = .07$, and the Practiced Go/No-Go runs, $t(30) = 1.20$, $p=.24$, $r^2 = .05$. For PEs, the main effect of Run Type was significant as well, $F(2,60) = 7.95$, $MSE = .00401$, $p<.001$, $\eta^2_p = .21$. PEs were significantly lower in Practiced Go/No-Go runs ($M = .03$, $SD = .04$) compared to Instructed Spacebar runs ($M = .09$, SD = .08) and Instructed Go/No-Go runs ($M = .07$, $SD = .08$), $t(30) = 3.86$, $p<.001$, $r^2 = .33$ and $t(30) = 3.06$, $p<.01$, $r^2 = .24$, respectively. PEs did not differ significantly between the latter two conditions, $t(30) = 1.11$, $p = .28$, $r^2 = .04$.

In a second analysis, we focused on the proportion of false hits when no response was required. The proportion of false hits in the Instructed Go/No-Go runs ($M = .09$, $SD = .09$) did not differ significantly from the proportion of false hits in the Practiced Go/No-Go runs ($M = .07$, $SD = .08$), $F(1,30) = 1.60$, $MSE = .004494$, $p=.22$, $\eta^2_p = .05$.

Discussion

The data of the diagnostic task are of main importance. The significant effect of Run Type indicated that RTs in the diagnostic task were longer in the Instructed Spacebar runs compared to the Instructed Go/No-Go runs. In turn, RTs were longer in the Instructed Go/No-Go runs compared to the Practiced Go/No-Go runs. The significant main effect of Trial Type indicated that RTs on test mapping trials were longer compared to RTs on control mapping incongruent trials and RTs on control mapping congruent trials. RTs on control mapping incongruent trials were only marginally longer compared to RTs on control mapping congruent trials. A marginal interaction was observed between Run Type and Trial Type. Further analysis of this interaction indicated that the difference between test mapping trials and control mapping trials (both congruent and incongruent) was similar for Instructed Go/No-Go runs and Instructed Spacebar runs. Finally, a trend was present indicating that the difference between test mapping trials and control mapping trials (both congruent and incongruent) was marginally smaller for Practiced Go/No-Go runs compared to Instructed Go/No-Go runs.

The results of Experiment 1 suggest that No-Go instructions that have not been overtly practiced before can bias performance automatically. In addition, it seems that practice reduces the automatic effect of No-Go instructions. The results also suggest that an unpracticed No-Go instruction leads to a behavioral effect of a similar size as the automatic effect of an unpracticed Go instruction, which refers to a response that is irrelevant for the diagnostic task. However, before speculating about the processes underlying these effects, we first wanted to replicate the findings of Experiment 1.

Experiment 2

The main purpose of Experiment 2 was to replicate the findings of Experiment 1. Two changes were made in comparison to Experiment 1. First, the interaction between Run Type and Trial Type was only marginally significant in Experiment 1. Additional confirmation was thus needed. In order to strengthen the effect of practice in Experiment 2, the number of practice trials in the Practiced Go/No-Go runs was quadrupled. Second, in the inducer task of the Instructed Spacebar runs of Experiment 1 participants were required to press the spacebar simultaneously with their thumbs. It is possible that some participants related the spacebar-press more to the left thumb and others more to the right thumb. In other words, an instruction such as "If E, press spacebar" may have been reinterpreted as "If E, press left thumb" or "If E, press right thumb". Participants in the Instructed Spacebar run could have recoded the spacebar response as a function of the response denoted by the control mapping. For instance, if the control mapping was “if Q, press right” and the test mapping “if E, press spacebar”, the test mapping would be recoded as “if E, press left (thumb)”. Because the diagnostic task also required left and right key-presses, it is thus not clear whether the effect of the test mapping in the Instructed Spacebar runs truly reflects the effect of a Go response, which is completely irrelevant for the diagnostic task. The conclusion that the behavioral effect of an unpracticed No-Go instruction is similar to the behavioral effect of an unpracticed Go instruction, which refers to a response that is irrelevant for the diagnostic task, may thus be premature. Experiment 2 therefore added an additional practice phase before the actual experiment started. In this phase, participants were trained to press two keys (“V" and “N") simultaneously with their thumbs. In the Instructed Spacebar runs, the spacebar response was also replaced by these two keys. As such, we had additional control over the onset between both responses.

The main goal of Experiment 2 was to see whether the results of Experiment 1 could be replicated. In other words, could we observe (a) an automatic effect of No-Go instructions, which is of similar size as the automatic effect of Go instructions referring to a response that is irrelevant for the diagnostic task and (b) a reduction of the automatic effect of No-Go instructions following the overt practice of these instructions.

Method

Twenty-Eight new students participated in Experiment 2. Participants received €10 in exchange for their participation. None of them had participated in Experiment 1. The materials and procedure of Experiment 2 were similar to Experiment 1 with some adjustments. First, the spacebar response was replaced by the requirement to press the N-key and the V-key of the AZERTY keyboard simultaneously. Prior to the actual experiment participants received a training phase in which they learned to press both keys simultaneously. To this end, participants had to press both keys simultaneously for 60 trials, when a circle on the screen center was presented. This circle was completely black and had a visual angle of 11.44°, the ITI in this additional phase was 500ms and the maximum response time 2000ms. If the difference between both key-presses was larger than 50ms (see, Hartstra, Kuhn, Verguts, & Brass, 2010 for a similar cutoff), the feedback message 'Niet gelijktijdig!' (i.e., 'Not simultaneously!' in Dutch) appeared on the screen center in a red font for 500ms.

The N- and V-keys also replaced the spacebar-response in the inducer task of the Instructed Spacebar runs. Although these runs did thus not include the spacebar as a response-key in the inducer task, we still refer to these runs as Instructed Spacebar runs. The test mapping in the Instructed Spacebar run now specified that the two keys needed to be pressed simultaneously when a particular stimulus was presented (e.g., "If P, press simultaneously"). Second, in the Practiced Go/No-Go runs 160 trials of the inducer task (120 Go trials, 40 No-Go trials) were administered before the onset of the diagnostic task.

Results

We first controlled our data with respect to the 50ms cut-off of the test mapping in the Instructed Spacebar runs. Five participants did not succeed in pressing the response keys on correct trials with an average onset smaller than 50ms. Data of these participants were excluded from the analyses.

Diagnostic task

The same exclusion criteria were used as in Experiment 1. This resulted in the removal of 6.9% of error trials. An additional 3.8% of the total of correct trials was identified as outliers and excluded. Means and standard deviations of each cell of the design are also presented in Table 2.

For the RTs, the main effect of Run Type was significant, $F(2,44) = 14.67$, $MSE = 2921$, $p < .001$, $\eta^2_p = .40$. RTs were longer on Instructed Spacebar runs ($M = 593$, $SD = 70$) than RTs on Instructed Go/No-Go runs ($M = 574$, $SD = 63$), $t(22) = 2.25$, $p < .05$, $r^2 = .19$. RTs on Instructed Go/No-Go runs were longer than RTs on Practiced Go/No-Go runs ($M = 543$, $SD = 55$), $t(22) = 3.94$, $p < .001$, $r^2 = .41$. The main effect of Trial Type was also significant, $F(2,44) = 54.76$, $MSE = 1415$, $p < .001$, $\eta^2_p = .71$. A trend was present, which suggested that RTs on control mapping congruent trials ($M = 546$, $SD = 59$) were slightly shorter than RTs on control mapping incongruent trials ($M = 555$, $SD = 55$), $t(22) = 1.78$, $p = .088$, $r^2 = .13$. On control mapping congruent trials the mapping of the inducer task refers to a left or right response (e.g., "if Q, press left"), which matches with the response required by the diagnostic task (i.e., left). On control mapping incongruent trials, the response required by the diagnostic task does not match with the response denoted by the mapping of the inducer task (i.e., right). This difference only slightly modulated RTs. RTs on test mapping trials (*M* = 608, *SD* = 67) were longer than RTs on control mapping congruent and control mapping incongruent trials: $t(22) = 9.08$, $p<.001$, $r^2 = .79$ and $t(22) = 7.05$, $p<.001$, $r^2 = .69$, respectively. On test mapping trials, the mapping of the inducer task refers to a No-Go response in the Go/No-Go runs and to simultaneous key-presses in the Instructed Spacebar runs.

The interaction between Run Type and Trial Type was significant, $F(4,88) = 2.96$, $MSE = 1103$, $p<.05$, $\eta^2_p = .12$. First, we focused on the difference between control mapping congruent and control mapping incongruent trials in the three types of runs. To this end, we did not consider the test mapping trials and conducted a 2 (control mapping congruent vs. control mapping incongruent trials) by 3 (Run Type) repeated measures ANOVA. The interaction between both these main effects was not significant, $F(2,44) = 1.88$, $MSE = 1066$, $p=.16$, $\eta^2_p = .08$. Second, we focused on the difference between control mapping incongruent trials and test mapping trials. A two-way ANOVA was thus now conducted in which the control mapping congruent trials were not considered. Trial Type (control mapping incongruent vs. test mapping) and Run Type interacted: $F(2,44) = 4.88$, $MSE = 1328$, $p<.05$, $\eta^2_p = .18$. Further analyses indicated that the difference between control mapping incongruent trials and test mapping trials was similar for Instructed Spacebar runs and Instructed Go/No-Go runs, $F(1,22) = 1.78$, $MSE = 1543$, $p=.20$, $\eta^2_p = .07$. In contrast, the difference between control mapping incongruent trials and test mapping trials was significantly smaller in the Practiced Go/No-Go runs than in the Instructed Go/No-Go runs, $F(1,22) = 8.95$, $MSE = 1444$, $p<.01$, $\eta^2_p = .29$. Finally, we considered the difference between control mapping congruent trials and the test mapping trials. Trial Type (control mapping congruent vs. test mapping) and Run Type did not interact: $F(2,44) = 1.44$, $MSE = 916$, $p=.25$, $\eta^2_p = .06$.

For the PEs, none of the effects was significant.

Inducer task

As in Experiment 1, a first analysis focused on stimuli, which were assigned to the control mappings of the inducer task. For RTs, incorrect trials (6.0% of the total amount of trials) and outliers (2.6% of the correct total of trials) were excluded. For RTs, the main effect of Run Type was significant, *F*(2,44) = 8.38, *MSE* =10187, $p<.001$, η^2_p = .27. RTs on Instructed Spacebar runs (*M* = 690, *SD* = 113) were larger than RTs on Instructed Go/No-Go runs (*M* = 601, *SD* = 133) and Practiced Go/No-Go runs (*M* = 574, *SD* = 98): *t*(22) = 2.88, $p<.01$, r^2 = .27 and *t*(22) = 4.93, $p<.001$, r^2 = .52 respectively. The latter two run types did not differ significantly, *t<1.* For the PEs, the main effect of Run Type was significant as well, *F*(2,44) = 9.38, *MSE* = .00597, $p<.001$, η^2_p = .30. PEs were significantly higher on Instructed Spacebar runs (*M* = .12, *SD* = .12) compared to Instructed Go/No-Go runs (*M* = .04, *SD* = .06) and Practiced Go/No-Go runs (*M* = .02, *SD* = .04), *t*(22) = 2.55, $p<.05$, r^2 = .23 and *t*(22) = 3.96, $p<.001$, r^2 = .42, respectively. PEs did not differ significantly in the latter two conditions, *t*(22) = 1.62, *p* = .11, r^2 = .11.

A trend was present, which indicated that the proportion of false hits in the Instructed Go/No-Go runs (*M* = .13, *SD* = .10) was slightly higher than the proportion of false hits in the Practiced Go/No-Go runs (*M* = .09, *SD* = .09), *F*(1,22) = 3.64, *p*=.07, *MSE* =.003611, η^2_p = .14.

Discussion

Again the results of the diagnostic task are of main importance. First, RTs in the Instructed Spacebar runs were longer than RTs in the Instructed Go/No-Go runs. In turn, RTs in the Instructed Go/No-Go runs were longer than in the Practiced Go/No-Go runs. Second, RTs on test mapping trials were longer compared to RTs on control mapping trials. Third, a trend was present (*p*= .088) suggesting that RTs on control mapping incongruent trials were longer than RTs on control mapping congruent trials. Finally, Run Type and Trial Type interacted. In line with Experiment 1, we did not observe any significant differences between the Instructed Go/No-Go runs and the Instructed Spacebar runs. When comparing the Instructed Go/No-Go runs with the Practiced Go/No-Go runs, the difference between control mapping incongruent trials and test mapping trials was smaller in the Practiced Go/No-Go runs than in the Instructed Go/No-Go runs. In contrast, the difference between control mapping congruent trials and test mapping trials was similar for Practiced Go/No-Go runs and Instructed Go/No-Go runs.

The results of Experiment 2 are partly in line with the results of Experiment 1. First, No-Go instructions that have not been overtly practiced before can automatically bias performance. Second, the effect of unpracticed No-Go instructions is similar to the effect of unpracticed Go instructions, which refer to a response that is irrelevant for the diagnostic task. Although the practice phase in the Practiced Go/No-Go runs was extended significantly, the results only partly confirm the trends observed in Experiment 1: practice reduced the difference between control mapping incongruent trials and test mapping trials, but practice did not reduce the difference between control mapping congruent trials and test mapping trials. In the General Discussion, we consider what these results tell us about unpracticed and practiced No-Go instructions.

General Discussion

The present study investigated whether No-Go instructions can automatically bias performance even without being practiced overtly before. To this end, two experiments were conducted. The results of these two experiments indicate that No-Go instructions, which have not been applied overtly before, can significantly bias performance when being irrelevant. An effect of similar size was obtained for Go instructions, which referred to a response that was irrelevant for the diagnostic task. Finally, practice seems to reduce the effect of No-Go instructions, albeit some caution is needed with respect to this latter conclusion because the effect of practice on the difference between control and test mapping trials was rather weak. We first consider the nature of the processes underlying the automatic effect of No-Go instructions. Next, we discuss the possible impact of practice on this effect.

Verbruggen and Logan (2008) proposed that associations between stimuli and the requirement not to respond (i.e., stimulus-stop associations) are formed through practice and, once established, they can be retrieved automatically. The present results suggest that such stimulus-stop associations may not only be formed on the basis of practice, but also on the basis of instructions. Such conclusion converges with previous accounts on the implementation of instructed S-R mappings. Liefooghe et al. (2012; 2013) proposed that when an upcoming task is prepared for on the basis of its instructions, these instructions are implemented into (S-R) associations, which can be triggered automatically (see also, Meiran, Braver, & Coles, 2012). The observation that the behavioral effect of an unpracticed No-Go instruction was of a similar size as the behavioral effect of an unpracticed Go instruction, suggests that the implementation of a No-Go instruction and the implementation of a Go instruction lead to functionally similar representations. The automatic effect of a No-Go instruction may thus not arise because this instruction refers to a No-Go response. The mere fact that an instruction refers to a response that is completely irrelevant for the diagnostic task could be sufficient to elicit a similar effect. As such, our findings indicate that the automatic effect of a No-Go instruction can be explained without calling upon processes related to (automatic) inhibition. However, the present findings only offer tentative evidence in support of such conclusion. Observing behavioral effects of a similar size, does not imply that similar processes underlie these behavioral effects. In addition, it remains unclear what pattern of results can be predicted if inhibitory processes would underlie the automatic effect of an unpracticed No-Go instruction but not the automatic effect of a Go instruction. Should the automatic effect of an unpracticed No-Go instruction be larger or smaller than the automatic effect of an unpracticed Go instruction? It becomes clear that additional research is needed to determine the extent by which the automatic effects of an unpracticed No-Go instruction and an unpracticed Go instruction are underpinned by the same type of processes or not.

An alternative interpretation of the present findings is that different response strategies were used in the diagnostic tasks of the Instructed Go/No-Go runs, Practiced Go/No-Go runs and Instructed Spacebar runs. Verbruggen and Logan (2009) observed that when the presence of a stop-signal in the stop-signal task (e.g., Vince, 1948) was cued in advance, participants adjusted their response strategies by increasing their response boundary. In other words, participants adopted a “wait-and-see” strategy in order to avoid false hits when a stop-signal was presented. In the present study, the instructions of the inducer task may also function as a signal that No-Go trials will follow and, accordingly, participants may have delayed responding for runs in which No-Go trials could follow (i.e., in the Instructed and Practiced Go/No-Go runs). Such an account cannot completely explain our results. First, in the diagnostic task participants were never required to produce a No-Go response. Adopting a “wait-and-see” strategy thus was futile in the diagnostic task. However, because the inducer and the diagnostic task were presented in close succession, participants could have adapted their response strategy for a whole run. Yet, the results indicate that RTs of the diagnostic task were in general longer for Instructed Spacebar runs than for Instructed Go/No-Go runs. In other words, participants would delay their responses to a larger extent in the Instructed Spacebar runs than in the Instructed Go/No-Go runs. This seems unlikely because in the Instructed Spacebar runs only Go responses were required and there was no need to delay responding. Alternatively, participants could have only delayed their responses for stimuli assigned to the test mappings. Such an account again has difficulties to explain why participants employed the same response strategy for a test mapping referring to a No-Go response (Instructed Go/No-Go runs) and a test mapping referring to a Go response (Instructed Spacebar runs). Finally, it should be noted that adopting a “wait-and-see” strategy in which participants increase their response boundary should not only increase response speed but also the level of accuracy (see for instance, Ratcliff, 1978). The current results, however, indicate that the overall accuracy was lower in the instructed Go/No-Go runs and in the Instructed Spacebar runs compared to the practiced Go/No-Go runs. Taken together, the present results are difficult to explain in terms of a shift in response strategy.

We now consider the effect of practice. The results of both experiments offer some indications that practice may reduce the size of the automatic effect of No-Go instructions. As we mentioned before, these findings are weak and should be interpreted with caution. The observed pattern of results is, however, in line with findings reported by Bugg and Scullin (2013). These authors investigated the difficulty in stopping pre-potent prospective-memory intentions, once a prospective-memory task is finished. They observed that deactivating prospective-memory intentions after a prospective-memory task was completed, is much harder when these intentions were not fulfilled in the prospective-memory task compared to the situation in which these intentions were fulfilled a number of times in the prospective-memory task. The study of Bugg and Scullin (2013) converges with the seminal study by Zeigarnik (1938), who observed that the recall of interrupted tasks is higher than the recall of completed tasks. Instructed Go/No-Go runs can be considered as a prospective memory task. The instructions of the inducer task are prospective intentions, the automatic effect of which is measured in the diagnostic task. In the instructed Go/No-Go runs these intentions have not been fulfilled prior to the diagnostic task, whereas in the practiced Go/No-Go runs the prospective intentions have been fulfilled a number of times before the onset of the diagnostic task. The smaller automatic effect observed for practiced No-Go instructions compared to unpracticed No-Go instructions may thus reflect difficulties in deactivating unfulfilled prospective intentions. However, a crucial difference between the present study and the study of Bugg and Scullin (2013) is that in the present study, the inducer task always followed the diagnostic task. Accordingly, the prospective intentions instructed at the onset of each run, remained valid throughout the diagnostic task and this both for instructed Go/No-Go runs and practiced Go/No-Go runs. In other words, participants could only deactivate their prospective intentions after the inducer task was completed at the end of a run. The difference between instructed Go/No-Go runs and practiced Go/No-Go runs thus is difficult to interpret in terms of the deactivation of prospective intentions. An alternative explanation is that practiced and unpracticed Go/No-Go instructions are represented in different formats. Meiran et al. (2012; see also Liefooghe et al., 2012) suggested that instructed S-R mappings lead to the formation of S-R associations, which are kept active in working memory. In contrast, practice leads to the formation of S-R associations in long-term memory. Performance is initially controlled by working memory. After practice, performance is controlled by the automatic retrieval of S-R associations from long-term memory (see also Logan, 1988). Within such view, the automatic effect of an unpracticed No-Go instruction is based on a working memory representation, whereas the automatic effect of a practiced No-Go instruction is based on a long-term memory association. This difference is supported by the observation that the overall RTs of the diagnostic task were significantly longer in the Instructed Go/No-Go runs than in the Practiced Go/No-Go runs. This was the case in both experiments. In the Instructed Go/No-Go runs, the load on working memory was probably much higher due to the active maintenance of the instructed S-R associations. The load on working memory was significantly reduced in the Practiced Go/No-Go runs, because long-term S-R associations were already formed through practice. Within this framework, it can be hypothesized that the active maintenance of instructed S-R associations induces more interference than S-R associations in long-term memory, which were formed through practice. At the present time, these interpretations are speculative and the effect of practice needs to be replicated and further investigated.

As a final comment we note that the difference between control mapping congruent trials and control mapping incongruent trials was small. It marginally significant in Experiment 1 (p= .053) and only a trend was present in Experiment 2 (p= .088). The absence of a significant instruction-based congruency effect suggests that participants did not represent the spatial connotation of the responses assigned to the control mappings of the inducer task. In the original procedure of Liefooghe et al. (2012, 2013), the spatial properties of the responses in the inducer task were highly relevant in order to perform the inducer task correctly. Accordingly, participants implemented these properties when preparing for the inducer task. In the present study, only the control mapping of the inducer task referred to a left or a right response. The test mapping referred to the requirement not to respond (Go/No-Go runs), the requirement to press the spacebar (Instructed Spacebar runs in Experiment 1) or the requirement to press two keys simultaneously (Instructed Spacebar runs in Experiment 2). Possibly, the combination of these S-R mappings did not encourage participants to encode the spatial properties of the responses to a sufficient degree. In the Go/No-Go runs, participants may have encoded the control mapping as a Go mapping and the test mapping as a No-Go mapping. In the Instructed Spacebar runs, participants may have implemented the control mapping as a mapping referring to a single-hand response and the test mapping as a mapping referring to a dual-hand response. Such alternative ways of encoding the S-R mappings may have resulted in the near absence of an instruction-based congruency effect. The influence of encoding strategies on response compatibility effects has been observed in previous research, for instance, with respect to the backward-compatibility effect (Wenke & Frensch, 2005) and the SNARC effect (Gevers et al., 2005).

To conclude, the present study tested whether No-Go instructions, which were not practiced overtly before, can lead to an automatic response bias. The results of two experiments confirm that this is the case. Although future work is needed to further understand the processes underlying this effect, the present study indicates that the automatic effect can be obtained for different types of instructions (see Theeuwes, De Houwer, Eder, & Liefooghe, 2015 for a similar point).

References

Bardi, L., Bundt, C., Notebaert, W., & Brass, M. (in press). Eliminating mirror responses by instructions. *Cortex*.

Bugg, J.M., & Scullin, M.L. (2013). Controlling Intentions The Surprising Ease of Stopping After Going Relative to Stopping After Never Having Gone. *Psychological Science*, *24,* 2463-2471.

Cohen, A.L., Bayer, U.C. , Jaudas, A., & Gollwitzer, P.M. (2008). Self-regulatory strategy and executive control: Implementation intentions modulate task switching and Simon task performance. *Psychological Research, 72*, 12-26.

De Houwer, J., Beckers, T., Vandorpe, S., & Custers, R. (2005). Further evidence for the role of mode-independent short-term associations in spatial Simon effects. *Perception & Psychophysics*, *67*, 659–666.

Donders, F. C. (1969). On the speed of mental processes. In W. G. Koster (Ed.), *Attention and performance II* (pp. 412–431). Amsterdam: North-Holland. (Original work published in 1868).

Everaert, T., Theeuwes, M., Liefooghe, B. , & De Houwer, J. (2014). Automatic motor activation by mere instruction. *Cognitive, Affective, and Behavioral Neuroscience, 14,* 1300-1309.

Gevers, W., Santens, S., Dhooge, E., Chen, Q., Van den Bossche, L., Fias, W, & Verguts, T. (2010). Verbal-spatial and visuo-spatial coding of number-space interactions. *Journal of Experimental Psychology: General*, *139*, 180-190.

Hartstra, E., Kühn, S., Verguts, T., & Brass, M. (2011). The implementation of verbal instructions: An fMRI study. *Human Brain Mapping, 32*, 1811-1824.

Liefooghe, B., De Houwer, J., & Wenke, D. (2013). Instruction-based response activation depends on task preparation. *Psychonomic Bulletin & Review*, 1–7.

Liefooghe, B., Wenke, D., & De Houwer, J. (2012). Instruction-based task-rule congruency effects. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*, 1325–1335.

Logan, G. D. (1985). Executive control of thought and action. *Acta Psychologica, 60*, 193-210.

Logan, G. D. (1988). Toward an instance theory of automatization. *Psychological Review*, *95*(4), 492–

527.

Meiran, N., Cole, M.W., Braver, T.S. (2012). When planning results in loss of control: intention-based reflexivity and working-memory. *Frontiers in Human Neuroscience,* 6:104.

Meiran, N., Pereg, M., Kessler, Y., Cole, M. W., & Braver, T. S. (2015). The Power of Instructions: Proactive Configuration of Stimulus–Response Translation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41,* 768 –786.

Meiran, N., Pereg, M., Kessler, Y., Cole, M. W., & Braver, T. S. (2015). Reflexive activation of newly instructed stimulus-response rules: evidence from lateralized readiness potentials in no-go trials. *Cognitive, Affective and Behavioral Neuroscience, 15, 365-376.*

Ratcliff, R. (1978). A theory of memory retrieval. *Psychological Review*, *85*, 59-108.

Stevens, M., Lammertyn, J., Verbruggen F., & Vandierendonck A. (2006). Tscope: A C library for programming cognitive experiments on the MS Windows platform. *Behavior Research Methods*, 38, 280-286.

Theeuwes, M., Liefooghe, B., & De Houwer, J. (2014). Eliminating the Simon effect by instruction. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 40,* 1470-1480.

Theeuwes, M., De Houwer, J., Eder, A., & Liefooghe, B. (2015). Congruency effects on the basis of instructed response-effect contingencies. *Acta Psychologica, 158,* 43-50.

Verbruggen, F., & Logan, G. D. (2008). Automatic and controlled response inhibition: Associative learning in the go/no-go and stop-signal paradigms. *Journal of Experimental Psychology*, *General. 137*, 649–672.

Verbruggen, F., & Logan, G. D. (2009). Proactive adjustments of response strategies in the stop-signal paradigm. *Journal of Experimental Psychology: Human Perception and Performance, 35*, 835-854.

Vince, M. A. (1948). The intermittency of control movements and the psychological refractory period. *British Journal of Psychology*, *38*(3), 149–157.

Wenke, D., & Frensch, P. A. (2005). The Influence of Task Instruction on Action Coding: Constraint Setting or Direct Coding? *Journal of Experimental Psychology: Human Perception and Performance, 31,* 803-819.

Zeigarnik, B. (1938). On finished and unfinished tasks. In W. D. Ellis (Ed.), *A source book of Gestalt psychology* (pp. 300–314). London, England: Harcourt, Brace and Co.

Table 1. Example of the types of runs and type of trials used in Experiment 1.

Run Types	Control Mapping	Test Mapping
Practiced Go/No-Go runs	*"If Q, press left"*	*"If E, do not press "*
Instructed Go/No-Go runs	*"If Q, press left"*	*"If E, do not press "*
Instructed Spacebar runs	*"If Q, press left"*	*"If E, press spacebar "*

Trial Types	Response in Diagnostic Task	Instruction Inducer Task
Control Mapping Congruent	pressing left to *Q*	*"If Q, press left"*
Control Mapping Incongruent	pressing right to Q	*"If Q, press left"*
Test mapping	pressing left or right to E	*"If E, do not press "* or *"If E, press spacebar "*

Table 2. Mean RTs and PEs of Experiments 1 and 2, as a function of Run Type and Trial Type. Corresponding standard deviations are printed between brackets.

Experiment 1							
		Control Mapping				Test Mapping	
	Run Type	Congruent		Incongruent			
RTs	Instructed Spacebar	596	(113)	609	(95)	666	(104)
	Instructed Go/No-Go	574	(95)	577	(94)	641	(97)
	Practiced Go/No-Go	545	(83)	559	(96)	588	(96)
PEs	Instructed Spacebar	.06	(.06)	.09	(.06)	.08	(.06)
	Instructed Go/No-Go	.05	(.05)	.07	(.05)	.08	(.07)
	Practiced Go/No-Go	.04	(.03)	.06	(.04)	.07	(.05)
Experiment 2							
RTs	Instructed Spacebar	568	(73)	578	(65)	633	(87)
	Instructed Go/No-Go	551	(70)	545	(67)	622	(76)
	Practiced Go/No-Go	520	(53)	540	(62)	570	(68)
PEs	Instructed Spacebar	.07	(.04)	.08	(.06)	.08	(.05)
	Instructed Go/No-Go	.07	(.05)	.06	(.05)	.07	(.07)
	Practiced Go/No-Go	.07	(.05)	.05	(.05)	.07	(.06)

Figure Captions

Figure 1. Outline of the Instructed Go/No-Go runs, Practiced Go/No-Go runs and Instructed Spacebar runs used in Experiment 1.

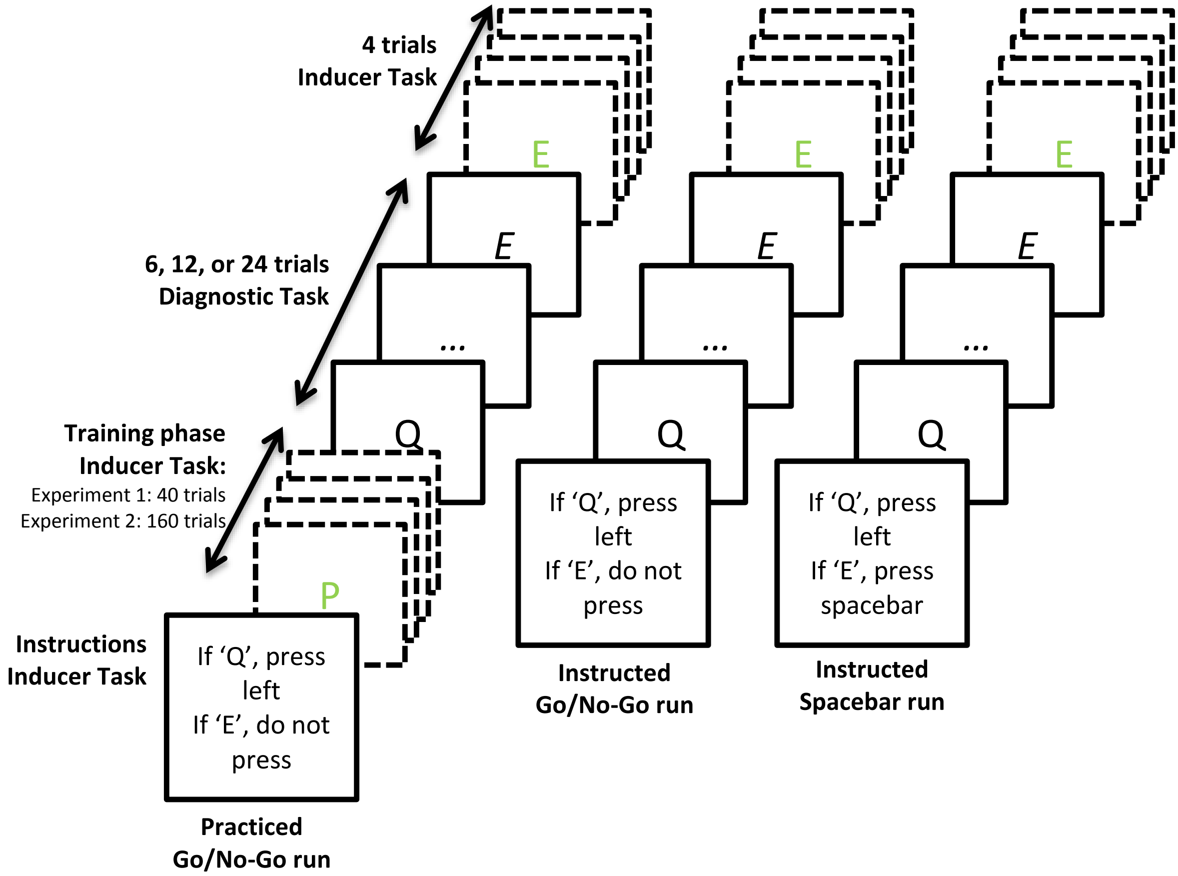
4 trials
Inducer Task
6, 12, or 24 trials
Diagnostic Task
Training phase
Inducer Task:
Experiment 1: 40 trials
Experiment 2: 160 trials
Instructions
Inducer Task
E
E
E
E
E
E
...
...
...
Q
Q
Q
P
If 'Q', press left If 'E', do not press
If 'Q', press left If 'E', do not press
If 'Q', press left If 'E', press spacebar
Practiced Go/No-Go run
Instructed Go/No-Go run
Instructed Spacebar run

Figure 1