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Contextual within-trial adaption of cognitive control:

Evidence from the combination of conflict tasks

Alodie Rey-Mermet * ¹

Miriam Gade * ^{1,2}

¹ University of Zurich

² Catholic University of Eichstaett-Ingolstadt

Author Note

Alodie Rey-Mermet and Miriam Gade, University of Zurich, Department of Psychology, Cognitive Psychology Unit, and Catholic University of Eichstaett-Ingolstadt, General Psychology. * joint first authorship

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Correspondence should be addressed to Alodie Rey-Mermet, University of Zurich, Department of Psychology, Cognitive Psychology Unit, Binzmuehlestr. 14, CH-8050 Zurich, email a.rey-mermet@psychologie.uzh.ch

Abstract

It is assumed that we recruit cognitive control (i.e., attentional adjustment and/or inhibition) to resolve two conflicts at a time, such as driving towards a red traffic light and taking care of a near-by ambulance car. A few studies have addressed this issue by combining a Simon task (which required responding with left or right key-press to a stimulus presented on the left or right side of the screen) with either a Stroop task (which required identifying the color of color words) or a Flanker task (which required identifying the target character among flankers). In most studies, the results revealed no interaction between the conflict tasks. However, these studies include a small stimulus set, and participants might have learned the stimulus-response mappings for each stimulus. Thus, it is possible that participants have more relied on episodic memory than on cognitive control to perform the task. In five experiments, we combined the three tasks pairwise, and we increased the stimulus set size to circumvent episodic memory contributions. The results revealed an interaction between the conflict tasks: Irrespective of task combination, the congruency effect of one task was smaller when the stimulus was incongruent for the other task. This suggests that when two conflicts are presented concurrently, the control processes induced by one conflict source can affect the control processes induced by the other conflict source.

Keywords: congruency effect, conflict adaption, Stroop, Flanker, Simon

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Imagine yourself driving home. You drive quickly but safely, while listening to the news from the radio. Thus, when you approach a red traffic light, you automatically put one foot on the brake pedal and the other on the clutch. However, if you hear an ambulance siren, you are able to ignore the traffic lights as well as the news coming from the radio in order to move to the side of the road. The cognitive processes we engage in when encountering such conflict situations are called cognitive control processes. In cognitive psychology, responding to a conflict has been assumed to require an adjustment of cognitive control, which allows us to activate goal-relevant features and inhibit irrelevant ones (e.g., Botvinick, Braver, Barch, Carter, & Cohen, 2001). The purpose of the present study was to investigate whether the cognitive control processes induced by one conflict (e.g., ignoring the information coming from the radio) can affect the control processes induced by another conflict (e.g., moving the car to the side of the road), when both conflicts are presented concurrently.

Conflict in goal-directed actions has been predominantly induced by incongruent trials (i.e., trials in which the stimulus is associated with two different response alternatives). To this end, three tasks have been used: the Stroop task (e.g., MacLeod, 1991), the Simon task (e.g., Simon & Small, 1969) and the Flanker Task (e.g., Eriksen & Eriksen, 1974). In the Stroop task, participants typically encounter color words printed in color. They are asked to indicate the color in which the word is displayed either by vocal responses or by key presses while ignoring the meaning of the word. Trials are incongruent when the meaning of the word does not correspond to the color in which the word is printed (e.g., the word “red” printed in green). In the Flanker task, participants encounter a row of characters and they are asked to classify the central

character while ignoring the flanking characters. For example, participants may be asked to respond to the color of the central letter while ignoring the color of the flanking letters. Trials are incongruent when the color of the central letter is different from the color of the flanking letters. In the Simon task, participants are asked to classify a stimulus while ignoring the position of this stimulus on the screen. For example, participants may encounter colored asterisks on the left or right side of the screen and they are asked to decide whether the asterisk is printed in red or green by pressing a left key for the color “red” and a right key for the color “green”. Trials are incongruent when the location of the asterisk is different from the location of the response key (e.g., a red asterisk presented on the right side but requiring a left key press).

In all three conflict tasks, participants are slower and more prone to errors on incongruent trials than on congruent trials (i.e., trials in which information converge to one response; Eriksen & Eriksen, 1974; MacLeod, 1991; Simon & Small, 1969; Stroop, 1935). This *congruency effect* occurs because in incongruent trials, the relevant feature has to be activated (i.e., the print color for the Stroop task, the central color for the Flanker task, and the location of the response key for the Simon task), whereas the irrelevant feature has to be inhibited (i.e., the word meaning, the color of the flanking letters, and the location on the screen, respectively).

The three conflict tasks have been categorized according to their source of conflict (Kornblum, 1994). Thus, the Simon task is different from the Stroop and Flanker tasks because its conflict occurs between the irrelevant stimulus feature (i.e., the left or right side of the screen) and the relevant response feature (i.e., the left or right key press; see also Hommel, 2011). In contrast, the Stroop and Flanker tasks induce a conflict between task-relevant and task-irrelevant stimulus features (see also Nigg, 2000). In recent individual differences studies, however, the Stroop and Flanker tasks have been further distinguished because they have been found to

measure two different inhibition processes (Friedman & Miyake, 2004; Stahl et al., 2014). The Stroop task is associated with the inhibition of pre-potent responses (i.e., the ability to deliberately suppress a dominant response, such as word reading). In contrast, the Flanker task is associated with the resistance to distractor interference (i.e., the ability to resist or resolve interference from the environment, such as the flanking characters).

So far, cognitive control research using the three conflict tasks has mainly focused on the congruency sequence effect (i.e., the reduced congruency effect after incongruent trials compared with congruent trials; Duthoo, Abrahamse, Braem, Boehler, & Notebaert, 2014; Egner, 2007). This effect was first explained by a conflict monitoring account (Botvinick et al., 2001). According to this account, the anterior cingulate cortex (ACC) monitors the environment for the presence of conflict. The detection of a conflict triggers adaption processes in the dorsolateral prefrontal cortex (dlPF). This results in enhanced cognitive control in the next trial in order to be prepared in the case of conflict. Thus, when two incongruent trials (i.e., two conflicts) are consecutive, performance is faster on the second incongruent trial. This results in a reduced congruency effect after incongruent trials, and gives rise to the congruency sequence effect. However, this account was challenged by accounts emphasizing the role of episodic memory processes in the congruency sequence effect (e.g., Mayr, Awh, & Laurey, 2003; see Braem, Abrahamse, Duthoo, & Notebaert, 2014, for an overview). One of the most influential episodic memory accounts is the feature integration account (see Hommel, 2004). According to this account, the stimulus and response features are bound together in an episodic memory representation. Thus, when some of the features from the previous trial are reused (partial feature repetitions), the episodic memory representation must be unbound. This requires more time than complete feature repetitions or alternations in which the episodic memory representation is either

completely reused or does not have to be unbound. Thus, as two consecutive incongruent trials require complete features alternations, the congruency effect is reduced after incongruent trials, which also explains the congruency sequence effect. More recently, another episodic memory account – the contingency learning account – has been put forward (Schmidt & De Houwer, 2011). According to this account, the congruency sequence effect results from learning the contingencies between stimulus and response features. That is, when half of the trials are congruent and the other half incongruent, the stimulus exemplars of the congruent trials are presented more frequently than the stimulus exemplars of the incongruent trials (e.g., in a four-choice task, four stimuli are congruent, while 12 are incongruent; Mordkoff, 2012). Thus, the sequences of two congruent stimulus exemplars are also encountered more frequently, which might explain why these sequences resulted in faster responses than the other trial sequences in the congruency sequence effect.

By focusing on the congruency sequence effect, previous research has investigated how control processes are influenced by the properties of the previous trial when the conflict sources are presented sequentially. Another line of research has focused on how cognitive control processes are adjusted within a block when the amount of conflict increases (Gratton, Coles, & Donchin, 1992; Logan & Zbrodoff, 1979; Lowe & Mitterer, 1982). In this research, the amount of conflict was manipulated by increasing the proportion of incongruent trials in one block whereas decreasing it in another block. The results typically showed a reduction of the congruency effect when the proportion of incongruent trials was increased. This proportion congruency effect has been interpreted as a contextual adaption of cognitive control. That is, the context (i.e., the amount of conflict) slowly impacts participants' expectations so that attention is directed away from the irrelevant information (but see Blais, Robidoux, Risko, & Besner, 2007).

In consequence, the impact of the conflict induced by the incongruent trials decreases. This reduces the congruency effect, yielding the proportion congruency effect.

So far, however, little is known about how cognitive control processes are adjusted within a trial when two different conflict sources are presented concurrently, such as in our example of driving a car when we are in front of a traffic light and we hear the ambulance siren. Only a few studies have addressed this question (see Table 1). In these studies, the Simon task was paired with either the Stroop or the Flanker task. All studies combining Stroop and Simon conflict sources found no interaction between the conflict sources (see the upper part of Table 1). That is, the magnitude of the Stroop congruency effect was similar when the trial was Simon congruent or incongruent. This finding has been interpreted as the fact that inhibiting the irrelevant stimulus feature in the Stroop task (i.e., the word meaning) and inhibiting the irrelevant response side in the Simon task occur in different processing stages (stimulus vs. response processing stages, such as proposed in Kornblum's (1994) taxonomy) or have different time courses for the involved effects (Hommel, 1997). For the studies combining Flanker and Simon conflict sources, the results were mixed: Whereas some studies found no interaction between the conflict sources, other studies found an interaction (see the bottom part of Table 1). This *within-trial congruency interaction* occurred because the Flanker congruency effect was smaller when Simon trials were incongruent compared to when they were congruent.

Together, these studies lead to inconclusive results. Therefore, it remains unclear whether two conflict sources presented in the same trial result in an interaction in the adjustment of cognitive control. Moreover, the studies reviewed above have open issues. First, Stroop and Flanker conflict sources were never combined. Therefore, no one has assessed whether and how the assumed different inhibition processes induced by these conflict sources would interact.

Second, a small stimulus set was used in most studies (see Akçay & Hazeltine, 2011, for an exception). For example, studies combining Stroop and Simon tasks typically used two color words printed in two colors and displayed in two locations; studies combining Flanker and Simon tasks used two letters in two locations. Thus, with such a small stimulus set, participants might have learned, at least to some extent, the stimulus-response mapping for each stimulus (Dreisbach, Goschke, & Haider, 2007). If so, participants relied more on episodic memory processes to perform the task, than on control processes (Hommel, 2004; Mayr et al., 2003). Thus, if less or no cognitive control is required, chances to observe an interaction among conflict sources and their resolution processes are reduced.

The purpose of the present study was to systematically investigate the within-trial congruency interaction in all combinations of the conflict sources, with a stimulus set large enough to circumvent episodic memory contributions. This is important because it would allow us to know whether cognitive control processes interact or are implemented independently (see Egner, 2008). To this end, five experiments were performed in which all three conflicts were combined pairwise (i.e., Stroop and Flanker in Experiment 1a, 1b, and 1c, Stroop and Simon in Experiment 2, as well as Flanker and Simon in Experiment 3). Moreover, the stimulus set was increased to four colors for the Stroop and Flanker tasks and four locations for the Simon task.

We hypothesized that if the stimulus set size was too small in the previous studies to not induce enough cognitive control processes (Egner, Delano, & Hirsch, 2007; Hommel, 1997; Kornblum, 1994; Simon & Berbaum, 1990; Stoffels & Molen, 1988; Wendt, Kluwe, & Peters, 2006), increasing the stimulus set size in the present study will result in more control requirements (see Dreisbach et al., 2007). In this case, if control processes interact, a within-trial congruency interaction would be expected in all five experiments. That is, for each task

combination, the congruency effect of one task would be smaller when the stimulus for the other task is incongruent compared to when it is congruent. However, it is also possible that the control processes induced by two conflict sources do not interact because they are independent of each other, such as proposed in the previous taxonomies (Friedman & Miyake, 2004; Kornblum, 1994; Nigg, 2000; Stahl et al., 2014). In this case, no within-trial congruency interaction would be found, and the congruency effect of one task would be the same, irrespective of whether the trials of the other task are incongruent or congruent. Logically, it is also possible that the congruency effect of one task is larger when the stimulus for the other task is incongruent compared to when it is congruent, because control processes draw on the same limited resources (Wickens, 1980).

Please note that as other cognitive processes than control processes were found to affect the congruency effect, we controlled for them as follows. First, to avoid observing a proportion congruency effect (Gratton et al., 1992; Logan & Zbrodoff, 1979; Lowe & Mitterer, 1982), we presented all trial types (i.e., incongruent and congruent) equally frequently. Second, to control for the impact of previous congruency in the present study, (e.g., Duthoo et al., 2014; Egner, 2007), we added in all analyses the variables with previous congruency. Therefore, the design of each experiment consisted of four within-subject variables (*current* and *previous congruency of the first task* as well as *current* and *previous congruency of the second task*). Third, to control for the impact of feature integration processes (e.g., Mayr et al., 2003), we removed trials with partial feature repetitions. Fourth, to test the impact of contingency learning (Schmidt & De Houwer, 2011), we conducted an experiment in which all stimulus exemplars were presented equally frequently (Experiment 1b). Finally, as previous research has shown that computing the congruency effect as the difference between incongruent and congruent trials may involve two

processes (i.e., the *inhibition* caused by the irrelevant response feature in incongruent trial and the *facilitation* occurring in congruent trials because the relevant and irrelevant features activate the correct response; Glaser & Glaser, 1982; Tzelgov, Henik, & Berger, 1992), we conducted an experiment (Experiment 1c) in which neutral trials (i.e., trials with only one response-relevant feature, such as a row of X's printed in red for the Stroop task) were included. An overview of all experiments is presented in Table 2.

Experiment 1a

Method

Participants. Twenty-four participants took part in Experiment 1 for either course credit or the payment of 15 CHF (19 women, mean age 23.5 years, SD = 5.3).

Material. The experiment consisted of a stimulus-response mapping block, pure Stroop and Flanker blocks as well as mixed blocks. The stimulus-response mapping block served as practice to learn the stimulus-response mapping. Pure Stroop and Flanker blocks were included in order that participants familiarized with each task separately and in order to control for the presence of congruency effects within each task. Mixed blocks were the critical blocks in which both tasks were combined. The stimuli and tasks for each block type are described separately.

Stimulus-response mapping block. The stimuli consisted of a row of four “x” colored in either red, brown, violet or white.¹ The stimulus for each trial was determined randomly. All stimuli were presented on a black background at the center of the computer screen in 28-point Arial Bold font. Participants used four response keys (y, v, m, -)², which were mapped to the colors red, brown, violet and white, respectively.

Pure Stroop blocks. The congruent stimuli were the four German words red, brown, violet, and white (i.e., “rot”, “braun”, “violett”, and “weiss”), displayed in red, brown, violet, and

white, respectively. Incongruent stimuli were stimuli in which the color words were printed in a non-corresponding color (e.g., the color word “red” printed in brown). All stimuli were presented similarly to the stimulus-response mapping block.

Pure Flanker blocks. For the Flanker task, we used the middle letter of the German words for red, brown, violet and white, (i.e., o for “rot”, a for “braun”, l for “violett”, and i for “weiss”), Each letter was presented five times in a row, displayed either in red, brown, violet or white. The stimuli were congruent when the color of the central letter was the same as the color of the flanking letters. The stimuli were incongruent when the color of the central letter was different from the color of the flanking letters. Incongruent stimuli were determined based on the color selected for the central stimulus (i.e., when the central stimulus was red, the color for the flanker stimuli was randomly drawn from the remaining three colors).

Mixed blocks. The material for the mixed blocks was the same as for the pure Stroop blocks, except for the following modifications. First, the middle letter of the German words for red, brown, violet or white (i.e., o for “rot”, a for “braun”, l for “violett”, and i for “weiss”) were displayed either in the same color as in the meaning of the word (Stroop congruent) or in a different color (Stroop incongruent). Moreover, the flanking letters of the color words (e.g., “r” and “t” for “rot”) were presented either in the same color as the color of the middle letter (Flanker congruent) or in a different color (Flanker incongruent).

Procedure. Participants were tested individually in one session in a sound-dim booth. Viewing distance to the monitor was about 50 cm. At the beginning, participants signed the informed consent sheet. Then, they were given short instructions about the task they had to carry out (Stroop, Flanker and the combination of the two). Before each change of block type (e.g., from the pure Stroop blocks to the mixed blocks), a short instruction for the now relevant task

was also given. For the stimulus-response mapping block, participants were instructed to indicate the color of the x's. For the pure Stroop blocks, they were instructed to indicate the color of the color word while ignoring its meaning. For the pure Flanker blocks, they were instructed to indicate the color of the central letter while ignoring the flanking letters. For the mixed blocks, they were instructed to indicate the color of the central letter while ignoring the meaning of the word and the flanking letters.

All participants first performed the stimulus-response mapping block for practice. After this block, half of the participants started with a pure Flanker block, followed by a pure Stroop block, whereas the other half started with a pure Stroop block followed by a pure Flanker block. After the first two blocks, all participants performed four mixed blocks in which the two tasks were combined. After these four mixed blocks, participants performed a pure Flanker block and a pure Stroop block in the same order as in the first two pure blocks (e.g., participants who started with a pure Flanker block, followed by a pure Stroop block, had then a pure Flanker block, followed by a pure Stroop block). The stimulus-response block included 96 trials while pure and mixed blocks included 192 trials each.

A trial started with the presentation of a yellow fixation cross presented centrally for 500 ms. Then, the stimulus was presented until a response. In case of an error, the word "Fehler" (i.e., error in English) was displayed in yellow and centrally for 250 ms. Finally, an intertrial interval of 500 ms occurred. The trial sequence is illustrated in Figure 1a. An overall feedback, which consisted of mean reaction time (RT) and error rate, was displayed at the end of each block. Participants could take brief breaks after each block.

For the pure Stroop and Flanker blocks, we had 50% congruent and 50% incongruent trials. For each mixed block, there were four trial types, occurring in equal probability (25%):

Stroop incongruent and Flanker incongruent, Stroop incongruent and Flanker congruent, Stroop congruent and Flanker incongruent, Stroop congruent and Flanker congruent. The trial types and their frequencies are described in Figure 1b. Please note that for the pure Stroop blocks and the mixed blocks, 25% of the trials were catch trials in which participants were asked to indicate the meaning of the word while ignoring the color(s).³ In these trials, the words “Wort lesen” (i.e., “read the word” in English) appeared in blue 150 pixels above the centrally presented stimulus. These catch trials were randomly interspersed in each block, and immediate repetitions were possible. No further constraints on randomization were imposed. Overall, the experiment took about 75 minute to be completed.

Data preparation and analysis. Dependent variables were RT and error rates. The stimulus-response mapping block, which served as a practice block, was not analyzed. Catch trials and the trial following a catch trial were excluded. Analyses on catch trials are shown in the appendix A. Data trimming removed errors and one trial following an error from the raw data set. We excluded RT faster than 3 Standard Deviations (SD) from the mean and slower than 3 SD from the mean for each condition.

Additionally, as partial feature repetitions between stimulus, responses, flanker and color words may affect the results and as there were enough data points, we controlled for trials including partial feature repetitions by removing them (see Akçay & Hazeltine, 2011, for a similar procedure). Overall, we dismissed 56.9 % of trials for the mixed blocks, 50.8 % of trials for the pure Stroop blocks and 47.7 % of trials for the pure Flanker blocks. The smallest mean number of observations per cell and participant was nine for the mixed blocks, 22 for the pure Stroop blocks, and 44 for the pure Flanker blocks. Please note that the analyses including trials with partial feature repetitions lead to the same pattern of results as reported in the present study.

For the statistical analyses⁴, we first investigated whether or not an interaction between the Stroop and Flanker tasks was found in the mixed blocks. To this end, we carried out a four-way repeated-measures analysis of variance (ANOVA) with the factors Stroop congruency (incongruent, congruent), Flanker congruency (incongruent, congruent), Stroop previous congruency (incongruent, congruent) and Flanker previous congruency (incongruent, congruent). Then, we also analyzed the pure blocks by conducting a two-way repeated-measures ANOVA with the factors congruency (incongruent, congruent) and previous congruency (incongruent, congruent) for the pure Stroop and Flanker blocks, respectively. All inferential statistical values, means and SD of these pure blocks analyses are presented in Appendix B. As our focus is mainly on RT data, and accuracy was close to ceiling in all experiments, accuracy data is referred to only when diverging from RT data. An alpha level of 0.05 was used for all statistical tests. Effect sizes are expressed as η_g^2 values (generalized eta square, cf. Olejnik & Algina, 2003).

Results

We focused on the main objective of the experiment, that is, the modulation of the congruency effect in one task by the congruency of the other task in the mixed blocks (e.g., the influence of the Flanker congruency on the Stroop congruency effect). The most relevant results are the RTs from the Stroop congruency effect, depending on whether the trials are Flanker congruent or incongruent. The descriptive results are depicted in Figure 2.

The results of the four-way ANOVA are shown in Table 3. Of most interest, this table reveals that the interaction between Stroop congruency and Flanker congruency was significant. Thus, the Stroop congruency effect was smaller when the stimuli were Flanker incongruent (160 ms), $t(23) = 10.49$, $p < .001$, compared to when they were Flanker congruent (232 ms), $t(23) =$

11.19, $p < .001$. This indicates the presence of a within-trial congruency interaction when the Stroop task is combined with the Flanker task (see Figure 2).

Moreover, Table 3 shows no other significant interaction involving Stroop congruency and Flanker congruency together. Therefore, the observed within-trial congruency interaction was not modulated by previous congruency (see Table 4).

Discussion

In Experiment 1a, we combined a Stroop task with a Flanker task in order to investigate whether the control processes induced by the Flanker conflict source affect the control processes induced by the Stroop conflict source. Importantly, we controlled for episodic memory contributions in two ways. First, we increased the stimulus set size in order to discourage to learn the stimulus-response mappings for each stimulus (Dreisbach et al., 2007). Second, we removed trials with partial feature repetitions (Mayr et al., 2003). The results showed that Flanker congruency modulated the Stroop congruency effect. More precisely, a smaller Stroop congruency effect was found when the stimuli were Flanker incongruent compared to when they were Flanker congruent. This within-trial congruency interaction demonstrates that when both conflict sources are presented concurrently, the control processes induced by one conflict source can affect the control processes induced by the other conflict source.

Experiment 1b

However, increasing the number of stimuli for each trial type in Experiment 1a lead to the disadvantage that we had a different number of stimulus exemplars per trial type (i.e., 4 stimulus exemplars when both tasks were congruent, 12 exemplars when one task was congruent and the other incongruent, and 36 exemplars when both tasks were incongruent). Thus, even if we presented each trial type equally often (i.e., 25% in the mixed blocks), the four stimulus

exemplars of the congruent-congruent trial type were presented more frequently than the other stimuli. This difference in stimulus frequency might have affected contingency learning (Mordkoff, 2012; Schmidt & De Houwer, 2011). When a stimulus and a response co-occur in time, then stimulus and response features are integrated into a common episodic memory representation (e.g., Hommel, 2004). This episodic memory representation is assumed to be strengthened by each new stimulus presentation. Therefore, as the four stimuli of the congruent-congruent trial type were presented most frequently in Experiment 1a, their episodic memory representations could have been more strengthened than those of the other trial types. This would account for the within-trial congruency interaction by explaining why RTs were the fastest for the congruent-congruent trial type (see Figure 2).

To rule out this possibility, we conducted Experiment 1b in which four exemplars of each stimulus type were selected randomly for each participant (i.e., four stimulus exemplars for congruent-congruent, congruent-incongruent, incongruent-congruent, and incongruent-incongruent trial types). Thus, if stimulus frequency contributed to the within-trial congruency interaction observed in Experiment 1a, its contribution would be controlled in Experiment 1b because all stimulus exemplars were presented equally often. Consequently, if stimulus frequency plays a role, performance on the congruent-congruent trial type would not be the fastest. Thus, no within-trial congruency interaction would be found because the Stroop congruency effect would be similar for Flanker congruent and incongruent trials.

Method

Participants. Twenty-seven new participants took part in Experiment 1b for either course credit or the payment of 15 CHF (22 women, mean age 23.0 years, $SD = 3.0$). The data of one participant was replaced because of accuracy at chance level (25%).

Material. The material was the same as in Experiment 1a, except that four exemplars of each stimulus type were selected randomly for each participant. This concerned the incongruent trials in the pure blocks as well as the incongruent-congruent, congruent-incongruent, and incongruent-incongruent trials in the mixed blocks.

Procedure, data preparation and analysis. Procedure, data preparation and analysis were the same as in Experiment 1a. By applying the same trimming criteria as in Experiment 1a, we removed 38.3 % of trials for the mixed blocks, 50.3 % of trials for the pure Stroop blocks and 37.1 % of trials for the pure Flanker blocks. The smallest mean number of observations per cell and participant was 31 for the mixed blocks, 22 for the pure Stroop blocks, and 34 for the pure Flanker blocks.

Results

As in Experiment 1a, we focus our analysis on the modulatory effect of the congruency in one task on the congruency effect in the other task. The most relevant results are thus the RTs from the Stroop congruency effect, depending on whether the trials are Flanker congruent or incongruent. The descriptive results are depicted in Figure 3.

The results of the four-way ANOVA are shown in Table 5. Of most interest, this table reveals that the interaction between Stroop congruency and Flanker congruency was significant. As in Experiment 1a, the Stroop congruency effect was smaller when the stimuli were Flanker incongruent (61 ms), $t(23) = 4.42, p < .001$, compared to when they were Flanker congruent (108 ms), $t(23) = 7.95, p < .001$. This indicates the presence of a within-trial congruency interaction when the Stroop task is combined with the Flanker task (see Figure 3). Importantly, this occurred even when the impact of contingency learning is controlled.

Moreover, Table 5 shows no other significant interaction involving Stroop congruency and Flanker congruency together. Therefore, the observed within-trial congruency interaction was not modulated by previous congruency (see Table 6).

Discussion

The results of Experiment 1b replicated those of Experiment 1a by showing a within-trial congruency interaction when the number of stimulus exemplars was the same for all trial types. That is, a smaller Stroop congruency effect was found when Flanker trials were incongruent compared to when they were congruent. This suggests that even when the impact of contingency learning is controlled (Mordkoff, 2012; Schmidt & De Houwer, 2011), the control processes induced by one conflict source can affect the control processes induced by the other conflict source.

Experiment 1c

In Experiments 1a and 1b, we computed the congruency effect as the difference between incongruent and congruent trials. As this difference may involve not only the *inhibition* induced by the irrelevant response feature in incongruent trials but also the *facilitation* induced in congruent trials (Glaser & Glaser, 1982; Tzelgov et al., 1992), it is possible that the within-trial congruency interaction found in both previous experiments results from the interaction of facilitation processes rather than of inhibitory processes. To rule out this possibility, we conducted a further experiment (Experiment 1c) in which neutral trials were included for each conflict source (i.e., Stroop and Flanker). We expected that if the within-trial congruency interaction results from an interaction of inhibitory processes, this interaction would also be found when the Stroop congruency effect was computed as the difference between incongruent and neutral trials.

Method

Participants. Twenty-four new participants took part in Experiment 1c for either course credit or the payment of 20 CHF (19 women, mean age 21.1 years, $SD = 1.9$).

Material. The material was the same as in Experiment 1a, except that neutral trials were included. For the Stroop task, neutral trials consisted of a row of “X” or “&” with either three, five or seven elements. For the sake of completeness, we also presented neutral trials in the Flanker task. These consisted of the colors dark pink and green, which were assigned to no response.

Procedure. The procedure was the same as in Experiment 1a, except for the following modifications. For the pure Stroop and Flanker blocks, we had 33% neutral, 33% congruent and 33% incongruent trials. For each mixed block, all trial types (i.e., Stroop incongruent and Flanker incongruent, Stroop incongruent and Flanker congruent, Stroop incongruent and Flanker neutral, Stroop congruent and Flanker incongruent, Stroop congruent and Flanker congruent, Stroop congruent and Flanker neutral, Stroop neutral and Flanker incongruent, Stroop neutral and Flanker congruent, Stroop neutral and Flanker neutral) occurred in equal frequency. To collect enough observations within in each condition, the number of blocks for the mixed blocks was increased to six blocks with 192 trials each.

Data preparation and analysis. Data preparation and analysis was similar to Experiment 1a. By applying the same trimming criteria, we removed 53.9 % of trials for the mixed blocks, 44.5 % of trials for the pure Stroop blocks and 41.7 % of trials for the pure Flanker blocks. The smallest mean number of observations per cell and participant was 31 for the mixed blocks, 9 for the pure Stroop blocks, and 13 for the pure Flanker blocks. However, when checking for balanced designs ahead of ANOVA, it turned out that some participants did not

provide means for all incorporated cells for the intended 4-way ANOVA. To include all participants, we run two three-way repeated-measures ANOVAs. In these ANOVAs, we investigated the influence of Flanker previous congruency separately from Stroop previous congruency. Thus, one three-way ANOVA included the factors Stroop congruency (incongruent, congruent, neutral), Flanker congruency (incongruent, congruent, neutral) and Flanker previous congruency (incongruent, congruent, neutral), while the other three-way ANOVA included Stroop congruency (incongruent, congruent, neutral), Flanker congruency (incongruent, congruent, neutral) and Stroop previous congruency (incongruent, congruent, neutral).

Results

As in the previous experiments, we focus on the modulatory effect of the congruency in one task on the congruency effect in the other task. The most relevant results are thus the RTs from the Stroop congruency effect (computed either as the difference between incongruent and congruent trials or as the difference between incongruent and neutral trials), depending on whether the trials are Flanker congruent or incongruent. The descriptive results are depicted in Figure 4.

The results of the two three-way ANOVAs are shown in Tables 7 and 8. Of most interest, these tables reveal that the interaction between Stroop congruency and Flanker congruency was significant in both analyses. Moreover, when the Stroop congruency effect was computed as the difference between incongruent and congruent trials, it was smaller for Flanker incongruent trials (162 ms), $t(22) = 10.60$, $p < .001$, than for Flanker congruent trials (251 ms), $t(22) = 13.22$, $p < .001$. This replicates the findings from Experiments 1a and 1b. Critically, when the Stroop congruency effect was computed as the difference between incongruent and neutral trials, a similar pattern was observed. That is, the Stroop congruency effect was smaller for Flanker

incongruent trials, (116 ms), $t(22) = 7.25, p < .001$, than for Flanker congruent trials (208 ms), $t(22) = 9.73, p < .001$.⁵

As in previous experiments, Tables 7 and 8 show no other significant interaction involving Stroop congruency and Flanker congruency together. Therefore, the observed within-trial congruency interaction was not modulated by previous congruency (see Table 9).

Discussion

The results of Experiment 1c replicated the previous findings by showing a within-trial congruency interaction, irrespective of whether the Stroop congruency effect was computed as the difference between incongruent and congruent trials or between incongruent and neutral trials. This suggests that the within-trial congruency interaction results from an interplay of inhibitory processes.

Experiment 2

Even if Stroop and Flanker tasks were found to trigger different inhibitory processes (i.e., the inhibition of prepotent response for the Stroop task, and the resistance to distractor interference for the Flanker task; see Friedman & Miyake, 2004; Stahl et al., 2014), both tasks are assumed to involve a conflict in stimulus features according to Kornblum's (1994) taxonomy (see also Nigg, 2000). Therefore, one may argue that the within-trial congruency interaction found in Experiments 1a, 1b, and 1c was not caused by the interplay of inhibitory processes, but simply resulted from the dimensional overlap, such as proposed in Kornblum's (1994) taxonomy. To test this possibility and to generalize the previous findings, we performed a further experiment in which we combined a Stroop task with a Simon task, because both conflict tasks have no dimensional overlap according to Kornblum's (1994) taxonomy. As in Experiment 1a, we increased the stimulus set size to four colors and four locations. Moreover, we removed trials

including partial feature repetitions and we added previous congruency as a within-subject variable in the analyses.

We hypothesized that if the within-trial congruency interaction results from a dimensional overlap (Kornblum, 1994), we would find no such interaction (see Egner et al., 2007; Hommel, 1997; Kornblum, 1994; Simon & Berbaum, 1990; Wendt et al., 2006). In this case, the Stroop congruency effect would be the same, irrespective of whether the stimuli are Simon incongruent or congruent. In contrast, if the within-trial congruency interaction results from the interplay of control processes, we would replicate the results of Experiments 1a, 1b and 1c. That is, the Stroop congruency effect would be smaller when the stimuli are Simon incongruent compared to when they are Simon congruent.

Method

Participants. Twenty-four new participants (20 women, mean age 24 years, SD = 3.7) took part in Experiment 2. The data of one participant had to be discarded because of accuracy at chance level (25%).

Material. As for Experiment 1a, the stimuli and tasks for each block type are described separately.

Stimulus-response mapping block. The stimuli for the stimulus-response mapping block were the same as in Experiment 1a, except that participants used the four response keys (*d*, *c*, *k*, *m*), which were mapped to the colors red, brown, violet and white, respectively. We used these response keys in order to give rise to the Simon task in the following blocks.

Pure Stroop blocks. The material for the pure Stroop blocks was the same as in Experiment 1a, except that participants used the four response keys (*d*, *c*, *k*, *m*).

Pure Simon blocks. The stimuli consisted of a row of four asterisks displayed in the colors red, brown, violet, and white. All stimuli were presented on a black background in 28 bold Arial font in one of the four areas limited by a cross hair (consisting of two 600 pixel long line which intersected at the center of the screen). Participants used the same four response keys with the same mapping as for the stimulus-response mapping block and the pure Stroop blocks. The stimulus for each trial was determined randomly. Stimuli were congruent when the position of the symbol on the screen corresponds to the location of the response key. In contrast, they were incongruent when the position of the symbol on the computer screen does not correspond to the location of the response key. In incongruent stimuli, the color of the stimulus determined which other position was randomly drawn. For instance, if the stimulus was printed in red, which goes along with the “C” response key (lower left), the position was randomly selected from the remaining three positions (upper left, upper right, lower right).

Mixed blocks. The material was the same as in the pure Stroop blocks, except that the color words were displayed as in the pure Simon blocks.

Procedure. The procedure was the same as in Experiment 1a, except that participants were instructed to indicate the color of the asterisks for the pure Simon blocks while ignoring their position and to indicate the color of the word for the mixed blocks while ignoring its meaning and its position. A trial sequence is illustrated in Figure 5a and the trial types are described in Figure 5b.

Data preparation and analysis. The data preparation and analysis were the same as in Experiment 1a, except for the following modifications. We removed 59.8 % of trials in the mixed block, 51.2% in the pure Stroop blocks, and 48.5% in the pure Simon blocks. The smallest

mean number of observations per cell and participant was seven for the mixed blocks, 20 for the pure Stroop blocks, and 40 for the pure Simon blocks.

Because of more errors in this experiment (ca. 6%) and the exclusion of one participant, we had too less observations to be able to perform the 4-way ANOVA. Therefore, we run two three-way repeated-measures ANOVAs that allowed us to use the whole sample of 23 participants. In these ANOVAs, we investigated the influence of Simon previous congruency separately from Stroop previous congruency. Thus, one three-way ANOVA included the factors Stroop congruency (incongruent, congruent), Simon congruency (incongruent, congruent) and Simon previous congruency (incongruent, congruent), whereas the other three-way ANOVA included Stroop congruency (incongruent, congruent), Simon congruency (incongruent, congruent) and Stroop previous congruency (incongruent, congruent).

Results

As in the previous experiments, we focused on the impact of the congruency of one task on the congruency effect of the other task in the mixed blocks (e.g., the Simon congruency on the Stroop congruency effect). The most relevant results are the RTs from the Stroop congruency effect, depending on whether the trials are Simon congruent or incongruent. These descriptive results are depicted in Figure 6.

The results of both three-way ANOVAs are shown in Tables 10 and 11. Of most interest, both tables reveal that the interaction between Stroop congruency and Simon congruency was significant. Thus, the Stroop congruency effect was smaller when the stimuli were Simon incongruent (176 ms), $t(22) = 6.18$, $p < .001$, compared to when they were Simon congruent (248 ms), $t(22) = 9.76$, $p < .001$. This indicates the presence of a within-trial congruency interaction when the Stroop task is combined with the Simon task (see Figure 4).

Moreover, Tables 10 and 11 show no other significant interaction involving Stroop congruency and Simon congruency together. Therefore, the observed within-trial congruency interaction was not modulated by previous congruency (see Table 12).

Discussion

The purpose of Experiment 2 was to extend the results of the previous experiments by investigating the within-trial congruency interaction when the conflict tasks – Stroop and Simon – did not have a dimensional overlap (Kornblum, 1994). The results of Experiment 2 replicate those of Experiment 1a by showing a within-trial congruency interaction. That is, the Stroop congruency effect was smaller when the stimuli were Simon incongruent compared to when they were Simon congruent. This within-trial congruency interaction shows that when both conflict sources are presented concurrently, the control processes induced by one conflict source can affect the control processes induced by the other conflict source. Importantly, this occurs even when the conflict tasks do not have a dimensional overlap (see Kornblum, 1994).

Experiment 3

In Experiment 3, we investigated whether the within-trial congruency interaction can be generalized to the last combination of conflict tasks, that is, the Flanker task with the Simon task. This is important because according to Kornblum's (1994) taxonomy, both tasks have no dimensional overlap, and thus should not induce an interaction between control processes. To this end, we combined the Flanker task used in Experiment 1a with the Simon task employed in Experiment 2. We expected that if Kornblum's (1994) taxonomy plays a role in the interplay of control processes, the within-trial congruency interaction would not be found in this experiment. That is, the Flanker congruency effect would be the same, irrespective of whether the stimuli were Simon incongruent or congruent. In contrast, if Kornblum's (1994) taxonomy is irrelevant

for the interaction between control processes within a trial, we would replicate the results of the previous experiments. That is, the Flanker congruency effect would be smaller when the stimuli are Simon incongruent compared to when they are Simon congruent.

Method

Participants. Twenty-four new participants (20 women, mean age 24 years, SD = 7.8) took part in Experiment 3.

Material. As for Experiments 1a and 2, the stimuli and tasks for each block type are described separately.

Stimulus-response mapping block. The stimuli for the stimulus-response mapping block were a row of four asterisks, except that participants used the four response keys (*d, c, k, m*), which were mapped to the colors red, brown, violet and white, respectively. We used these response keys in order to give rise to the Simon task in the following blocks.

Pure Flanker blocks. The material for the pure Flanker blocks was the same as in Experiment 1a.

Pure Simon blocks. The material for the pure Simon blocks was the same as in Experiment 2.

Mixed blocks. The material was the same as in the pure Flanker blocks, except that the colored X were displayed as in the pure Simon blocks.

Procedure. The procedure was the same as in Experiments 1a and 2, except that participants were instructed to indicate the color of the middle “X” for the mixed blocks while ignoring the position of the five x’s. A trial sequence is illustrated in Figure 7a and the trial types are described in Figure 7b.

Data preparation and analysis. The data preparation and analysis were the same as in Experiment 1a. We removed 59.6% of the trials in the mixed blocks, 51.2 % for the pure Flanker blocks and 51.1 % for the pure Simon blocks. The smallest mean number of observations per cell and participant was 13 for the mixed blocks, 20 for the pure Flanker blocks, and 40 for the pure Simon blocks. Please note that because of a technical error, data of half of the pure Flanker blocks were not collected.

Results

As in the previous experiments, we focused on the modulation of the congruency of one task on the congruency effect of the other task (e.g., the Simon congruency on the Flanker congruency effect). The most relevant results are the RTs from the Flanker congruency effect, depending on whether the trials are Simon congruent or incongruent. These descriptive results are depicted in Figure 8.

The results of the four-way ANOVA are shown in Table 13. Of most interest, this table reveals that the interaction between Flanker congruency and Simon congruency was significant. Thus, the Flanker congruency effect was smaller when the stimuli were Simon incongruent (77 ms), $t(23) = 11.90$, $p < .001$, compared to when they were Simon congruent (116 ms), $t(23) = 12.56$, $p < .001$. This indicates the presence of a within-trial congruency interaction for this task combination (see Figure 8).

Moreover, Table 13 shows no other significant interaction involving Flanker congruency and Simon congruency together. Therefore, the observed within-trial congruency interaction was not modulated by previous congruency (see Table 14).

Discussion

The results of Experiment 3 replicate those of the previous experiments by showing a within-trial congruency interaction when the Simon task was combined with the Flanker task. That is, the Flanker congruency effect was smaller when the stimuli were Simon incongruent compared to when they were Simon congruent. Together, this suggests that irrespective of the task combination and of the taxonomies relating these conflict tasks (Friedman & Miyake, 2004; Kornblum, 1994; Stahl et al., 2014), the control processes induced by one conflict source can affect the control processes induced by the other conflict source, when both conflict sources are presented concurrently.

The results of Experiment 3 challenge, however, those from Akçay and Hazeltine (2011), which showed no within-trial interaction between the Flanker and Simon tasks. In that study, the stimulus set was increased to four or five locations aligned horizontally. This contrasts with the Simon task we used in the present study in which the stimuli were displayed in one of four quadrants and thus involve a horizontal as well as vertical alignments. This difference in the Simon tasks might explain the discrepancy in the results because the vertical Simon task involve different control processes than the horizontal Simon task (Vallesi, Mapelli, Schiff, Amodio, & Umiltà, 2005; Wühr & Biebl, 2011). Therefore, it possible that the control processes induced by the vertical Simon task are responsible for the within-trial congruency interaction. However, this has to be investigated in further research before any firm conclusion can be drawn.

General Discussion

The purpose of the present study was to determine how cognitive control processes are adjusted within a trial when two different conflict sources are presented concurrently. To this end, we combined pairwise the three conflict tasks (i.e., Stroop and Flanker in Experiments 1a,

1b and 1c, Stroop and Simon in Experiment 2, as well as Flanker and Simon in Experiment 3). In all experiments, we increased the stimulus set to four colors and four locations to circumvent episodic memory contributions; we added previous congruency as a factor in the analyses to take into account the possible impact of the properties of the previous trial; and we removed trials with partial feature repetitions to control for feature integration. More specifically, we controlled for contingency learning by conducting an experiment (Experiment 1b) in which the same number of stimulus exemplars were presented across trial types. We also ensured the involvement of inhibitory processes by including neutral trials (Experiment 1c). In all five experiments, the results showed an interaction between the conflict sources. That is, within the same trial, the congruency effect of one task was reduced when the stimulus was incongruent for the other task.

To our knowledge, the present study is the first to provide evidence for this within-trial congruency interaction, irrespective of the combination of the conflict sources. We interpret this finding as resulting from the interplay of control processes, in particular inhibitory processes. That is, when both conflict sources are presented concurrently, the control processes induced by one conflict source affect the control processes induced by the other conflict source. We refer to this interplay as a contextual within-trial adaption of control processes because the control processes are implemented within the trial boundaries probably by means of time, stimulus material and requested responses.

The present results challenge the previous taxonomies (Friedman & Miyake, 2004; Kornblum, 1994; Nigg, 2000; Stahl et al., 2014). That is, we found a within-trial congruency interaction for the tasks sharing a dimensional overlap but underlying different inhibitory processes, such as Stroop and Flanker, as well as for the tasks sharing no dimensional overlap,

such as Stroop and Simon as well as Flanker and Simon. However, although the present results generalize across all task combinations, there exist some differences. In contrast to the within-trial congruency interaction between Stroop and Simon conflict sources (Experiment 2) as well as between Flanker and Simon conflict sources (Experiment 3), the within-trial congruency interaction between the Stroop and Flanker tasks found in Experiments 1a and 1c seem to also result from faster responses when the trial is Stroop and Flanker incongruent (but see Experiment 1b for an exception). Thus, the control processes involved in the Stroop and Flanker tasks interact to larger degree than the control processes involved in the other task combinations. Thus, as suggested by Nigg (2000) and Stahl et al. (2014), the Stroop and Flanker tasks might be closely linked.

Although the present results are compelling, it remains unclear which processes are involved for the resolution of the conflicts and how these processes interact to result in the within-trial congruency interaction. Whereas Nigg (2000) as well as Friedman and Miyake (2004, see also Stahl et al., 2014) used the Flanker and the Stroop task as prototypical inhibition tasks, episodic memory accounts and activation-based accounts were put forward to explain increased reaction times in incongruent trials (see Hommel, 2011; MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003; Mayr et al., 2003). Even though we controlled for episodic memory influences, we cannot firmly conclude that the processes resolving conflict is the inhibition of this irrelevant information. Indeed, activation-based accounts (see Philipp, Gade, & Koch, 2007; Schneider & Anderson, 2010) have been successfully applied to similar phenomena, such as asymmetric task switch costs (i.e., costs arising when participants switch to the “easier” or better practiced task than when they switched to the “difficult” or less practiced task). This asymmetry in switch costs was explained neither by inhibition processes nor with recurrence of episodic

memory representations that have to be unbound and newly assembled (see Braem et al., 2014, for a review). Rather, it was explained by assuming that the former activation of less well practiced tasks that was relevant in the trial before the switch lead to an activation disadvantage for the “easier” task that has to be overcome before performing this task (see Yeung & Monsell, 2003). To transfer this explanation to our findings, we must assume that when both conflict sources are presented concurrently, the source of conflict which is first processed induces more activation. Thus, when the second source of conflict is processed, this second conflict resolution processes benefit from an already heightened activation level, which would make the second conflict source easier to resolve and thus would explain the small increases in RT level we observed (see Figures 2, 3 4, 6, and 8).

Another related question is about the time course of the control processes involved in the resolution of both conflicts. It is possible that although both conflicts are presented concurrently, they are processed sequentially, such as in the congruency sequence effect. Previous research has revealed that the Simon effect for instance is present early in the reaction time distribution, whereas the Stroop effect is more pronounced towards the end of the distribution (Hommel, 1997). We therefore performed a quintile analysis on our data (see Appendix C) to investigate whether the within-trial congruency interaction is bound to the later quintiles during reaction time distribution or whether this interaction occurs throughout. The results revealed a similar pattern of results across quintiles as the pattern presented in the different results sections. These findings challenge the view that the control processes induced by one conflict task progressed during the time needed by the control processes of the other conflict task to be completed. Therefore, both the control processes involved in the resolution of both conflicts do not appear to work sequentially.

More generally, the present results are also important for the debate whether control processes work either locally within a conflict or globally by spilling over to several conflict sources (Egner, 2008; see Braem et al., 2014, for an overview). In previous studies in which the focus was on the congruency sequence effect, the results were mixed. A congruency sequence effect was found across conflict sources in some studies (e.g., Akçay & Hazeltine, 2008; Fernandez-Duque & Knight, 2008; Freitas, Bahar, Yang, & Banai, 2007; Funes, Lupiáñez, & Humphreys, 2010; Kunde & Wühr, 2006; Notebaert & Verguts, 2008), but not in others (e.g., Kiesel, Kunde, & Hoffmann, 2006; Kunde, Augst, & Kleinsorge, 2012; Schlaghecken, Refaat, & Maylor, 2011; Spapé, Band, & Hommel, 2011; Verbruggen, Liefoghe, Notebaert, & Vandierendonck, 2005; Wendt et al., 2006). In the present study, we focused on the within-trial congruency interaction and we found control processes operating across conflict sources. Thus, the present study provides further evidence for global control processes.

It is important to note that the conflict tasks we used are special cases because they slightly deviated from the standard tasks, such as the Stroop task in which the complete word is presented in an incongruent color, or the Simon task in which the stimuli are presented either to the left or right of the screen. These deviations might have affected the underlying control processes. For example, when combining the Stroop and Flanker together such as in Experiments 1a, 1b and 1c, it is possible that presenting the central letter of a word in a different color than the remainder of its letters disrupts reading processes, thereby reducing the Stroop congruency effect. Similarly, it is also difficult to assess the impact of catch trials in the within-trial congruency interaction. Please note that these concerns are mainly for the combination of the Stroop and Flanker conflicts, but not for the combination of the Stroop and Simon conflicts or the combination of the Flanker and Simon conflicts. Nevertheless, this emphasizes the necessity

of further research in which the present findings would be generalized with the more standard versions of the Stroop, Simon and Flanker tasks.

To summarize, the results of the present study show that within the same trial, the congruency effect of one task was reduced when the stimulus was incongruent for the other task. Importantly, this within-trial congruency interaction occurred irrespective of the combination between the Stroop, Flanker and Simon tasks. We interpreted these findings as the result of a contextual adaption of control processes that occurs within the time course of a single trial.

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Footnotes

¹ Please note that the colors “brown”, “red”, “violet” and “white” were used in order to have German color words (“braun”, “rot”, “violett”, and “weiss”) with an odd number of letters and thus appropriate to create a Flanker conflict in the mixed blocks.

² On a QWERTZ keyboard, the response keys represent every third key on the bottom row.

³ In Experiments 1a, 1b, and 1c, the Stroop conflict results from the competition between the color of the central letter and the meaning of the word. Previous research has revealed that this single-letter Stroop task can reduce the Stroop congruency effect (Besner, Stolz, & Boutilier, 1997). Therefore, to make the meaning of the word as salient as possible and thus to enhance conflict in incongruent trials, we included catch trials.

⁴ The counterbalancing of block order did not interact with any critical factors in all experiments. For this reason, we reported the analyses without this factor.

⁵ Please note that the pattern of results for Flanker neutral trials is similar to Flanker incongruent trials (see the right part of Figure 4). Thus, the Flanker neutrals trials (i.e., flanker colors associated to none of the responses) were not resolved faster as Flanker incongruent trials (i.e., flanker colors associated to a response but incongruent to the target). Thus, the Flanker neutral trials we used did not work properly as neutral trials (see Steinhauser & Hübner, 2009).

Table 1

Studies combining Stroop, Simon and Flanker tasks.

Combination of conflict sources	Study	Interaction?
Stroop and Simon	Egner, Delano, & Hirsch (2007)	no
	Hommel (1997) – Exp. 1	no
	Kornblum (1994)	no
	Simon & Berbaum (1990)	no
	Wendt, Kluwe, & Peters (2006) – Exp. 2b	no
Flanker and Simon	Akçay & Hazeltine (2011) – Exp. 1	no
	Akçay & Hazeltine (2011) – Exp. 2	no
	Hommel (1997) – Exp. 2	yes
	Stoffels & Molen (1988) – Exp. 1	no
	Stoffels & Molen (1988) – Exp. 2	yes
	Wendt et al. (2006) – Exp. 2a	yes

Note. We focused on the three tasks – Stroop, Simon, and Flanker – we used in the present study.

However, there exist studies combining other conflict tasks, such as a priming task with a Simon task (Boy, Husain, & Sumner, 2010; Kunde & Wühr, 2006; Schlaghecken et al., 2011), a global-local task with a Simon task (Hommel, 1997), a valence-based interference task with a Simon task (Kunde et al., 2012), or a color Stroop task with a spatial Stroop task (Kim, Chung, & Kim, 2010). The results were also mixed. An interaction were found in some studies (Boy et al., 2010; Hommel, 1997; Kunde & Wühr, 2006; Schlaghecken et al., 2011), but not in others (Boy et al., 2010; Kim et al., 2010; Kunde et al., 2012).

Table 2

Overview of the five experiments.

Experiment n°	Combination of conflict sources	General trial types	Stimulus selection in case of incongruent trial types
1a	Stroop and Flanker	incongruent and congruent	random
1b	Stroop and Flanker	incongruent and congruent	4 stimulus exemplars
1c	Stroop and Flanker	incongruent, congruent and neutral	random
2	Stroop and Simon	incongruent and congruent	random
3	Flanker and Simon	incongruent and congruent	random

Table 3

Experiment 1a: Inferential statistical values for the 4-way repeated-measures analysis of variance (ANOVA) with the factors Stroop congruency (incongruent, congruent), Flanker congruency (incongruent, congruent), Stroop previous congruency (incongruent, congruent), and Flanker previous congruency (incongruent, congruent).

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Stroop congruency	1, 23	189.90	<0.001	0.25	21.88	<0.001	0.10
Flanker congruency	1, 23	1.74	0.20	<0.01	0.02	0.89	<0.01
Stroop previous congruency	1, 23	0.56	0.46	<0.01	1.83	0.19	<0.01
Flanker previous congruency	1, 23	3.21	0.09	<0.01	0.47	0.50	<0.01
Stroop congruency x Flanker congruency	1, 23	10.51	<0.01	<0.01	1.6	0.22	<0.01
Stroop congruency x Stroop previous congruency	1, 23	13.94	<0.01	<0.01	2.87	0.10	<0.01
Flanker congruency x Stroop previous congruency	1, 23	0.09	0.77	<0.01	0.28	0.60	<0.01
Stroop congruency x Flanker previous congruency	1, 23	0.13	0.72	<0.01	0.39	0.54	<0.01
Flanker congruency x Flanker previous congruency	1, 23	4.06	0.06	<0.01	0.02	0.90	<0.01
Stroop previous congruency x Flanker previous congruency	1, 23	1.91	0.18	<0.01	1.7	0.20	<0.01

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Stroop congruency x Flanker congruency x Stroop previous congruency	1, 23	1.65	0.21	<0.01	0.24	0.63	<0.01
Stroop congruency x Flanker congruency x Flanker previous congruency	1, 23	0.36	0.56	<0.01	0.08	0.78	<0.01
Stroop congruency x Stroop previous congruency x Flanker previous congruency	1, 23	4.05	0.06	<0.01	0.04	0.85	<0.01
Flanker congruency x Stroop previous congruency x Flanker previous congruency	1, 23	0.23	0.64	<0.01	0.01	0.93	<0.01
four-way interaction	1, 23	0.75	0.40	<0.01	0.53	0.47	<0.01

Note. Effect sizes are expressed as generalized η^2 values.

Table 4

Experiment 1a: Means and standard deviations (in parentheses).

		Stroop previous incongruent		Stroop previous congruent	
		Flanker	Flanker	Flanker	Flanker
Dependent measures and trial types		previous incongruent	previous congruent	previous incongruent	previous congruent
<i>Reaction times</i>					
Stroop incongruent	Flanker incongruent	999 (189)	1003 (151)	1004 (170)	1101 (246)
	Flanker congruent	1045 (200)	1015 (201)	1055 (178)	1066 (226)
Stroop congruent	Flanker incongruent	862 (180)	898 (146)	831 (176)	854 (129)
	Flanker congruent	820 (149)	814 (156)	812 (146)	807 (161)
<i>Accuracy</i>					
Stroop incongruent	Flanker incongruent	0.95 (0.04)	0.95 (0.04)	0.95 (0.06)	0.94 (0.06)
	Flanker congruent	0.95 (0.06)	0.95 (0.06)	0.94 (0.09)	0.93 (0.07)
Stroop congruent	Flanker incongruent	0.97 (0.04)	0.98 (0.03)	0.98 (0.04)	0.97 (0.04)
	Flanker congruent	0.98 (0.02)	0.98 (0.03)	0.98 (0.03)	0.98 (0.04)

Table 5

Experiment 1b: Inferential statistical values for the 4-way repeated-measures analysis of variance (ANOVA) with the factors Stroop congruency (incongruent, congruent), Flanker congruency (incongruent, congruent), Stroop previous congruency (incongruent, congruent), and Flanker previous congruency (incongruent, congruent).

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Stroop congruency	1, 26	49.64	<0.001	0.05	70.89	<0.001	0.26
Flanker congruency	1, 26	19.12	<0.001	0.02	3.65	0.07	<0.01
Stroop previous congruency	1, 26	23.75	<0.001	<0.01	1.19	0.29	<0.01
Flanker previous congruency	1, 26	0.18	0.68	<0.01	0.09	0.77	<0.01
Stroop congruency x Flanker congruency	1, 26	10.13	<0.01	<0.01	0.49	0.49	<0.01
Stroop congruency x Stroop previous congruency	1, 26	0.2	0.66	<0.01	10.47	<0.01	0.02
Flanker congruency x Stroop previous congruency	1, 26	1.69	0.20	<0.01	0.65	0.43	<0.01
Stroop congruency x Flanker previous congruency	1, 26	0.13	0.72	<0.01	0.34	0.56	<0.01
Flanker congruency x Flanker previous congruency	1, 26	1.78	0.19	<0.01	0.2	0.66	<0.01
Stroop previous congruency x Flanker previous congruency	1, 26	1.47	0.24	<0.01	0.34	0.57	<0.01

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Stroop congruency x Flanker congruency x Stroop previous congruency	1, 26	0.16	0.69	<0.01	0.00	0.95	<0.01
Stroop congruency x Flanker congruency x Flanker previous congruency	1, 26	0.06	0.80	<0.01	0.75	0.39	<0.01
Stroop congruency x Stroop previous congruency x Flanker previous congruency	1, 26	0.03	0.85	<0.01	1.69	0.20	<0.01
Flanker congruency x Stroop previous congruency x Flanker previous congruency	1, 26	1.64	0.21	<0.01	3.84	0.06	<0.01
four-way interaction	1, 26	0.06	0.81	<0.01	0.06	0.80	<0.01

Note. Effect sizes are expressed as generalized η^2 values.

Table 6

Experiment 1b: Means and standard deviations (in parentheses).

		Stroop previous incongruent		Stroop previous congruent	
		Flanker	Flanker	Flanker	Flanker
Dependent measures and trial types		previous incongruent	previous congruent	previous incongruent	previous congruent
<i>Reaction times</i>					
Stroop incongruent	Flanker incongruent	1020 (164)	983 (160)	1026 (196)	988 (177)
	Flanker congruent	1008 (201)	961 (177)	979 (197)	978 (197)
Stroop congruent	Flanker incongruent	966 (199)	915 (190)	967 (187)	918 (179)
	Flanker congruent	901 (176)	858 (183)	869 (186)	861 (182)
<i>Accuracy</i>					
Stroop incongruent	Flanker incongruent	0.91 (0.07)	0.88 (0.09)	0.90 (0.09)	0.88 (0.08)
	Flanker congruent	0.92 (0.08)	0.89 (0.08)	0.91 (0.09)	0.91 (0.07)
Stroop congruent	Flanker incongruent	0.95 (0.05)	0.97 (0.03)	0.97 (0.02)	0.97 (0.03)
	Flanker congruent	0.97 (0.03)	0.98 (0.03)	0.97 (0.04)	0.98 (0.02)

Table 7

Experiment 1c: Inferential statistical values for the 3-way repeated-measures analysis of variance (ANOVA) with the factors Stroop congruency (incongruent, congruent, neutral), Flanker congruency (incongruent, congruent, neutral), and Flanker previous congruency (incongruent, congruent, neutral).

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Stroop congruency	2, 44	163.67	<0.001	0.23	38.12	<0.001	0.13
Flanker congruency	2, 44	0.55	0.58	<0.01	0.47	0.63	<0.01
Stroop previous congruency	2, 44	0.51	0.61	<0.01	0.01	0.99	<0.01
Stroop congruency x Flanker congruency	4, 88	12.25	<0.001	0.03	0.70	0.59	<0.01
Stroop congruency x Flanker previous congruency	4, 88	0.63	0.64	<0.01	2.40	0.06	<0.01
Flanker congruency x Flanker previous congruency	4, 88	1.34	0.26	<0.01	0.34	0.85	<0.01
Stroop congruency x Flanker congruency x Flanker previous congruency	8, 176	0.33	0.95	<0.01	0.65	0.73	<0.01

Note. Effect sizes are expressed as generalized η^2 values. Uncorrected degrees of freedom are presented for better readability.

Table 8

Experiment 1c: Inferential statistical values for the -3way repeated-measures analysis of variance (ANOVA) with the factors Stroop congruency (incongruent, congruent, neutral), Flanker congruency (incongruent, congruent, neutral), and Stroop previous congruency (incongruent, congruent, neutral).

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Stroop congruency	2, 44	171.77	<0.001	0.25	37.79	<0.001	0.12
Flanker congruency	2, 44	0.05	0.95	<0.01	0.54	0.59	<0.01
Stroop previous congruency	2, 44	0.51	0.60	<0.01	0.48	0.62	<0.01
Stroop congruency x Flanker congruency	4, 88	7.83	<0.001	0.02	0.76	0.55	<0.01
Stroop congruency x Stroop previous congruency	4, 88	0.64	0.63	<0.01	0.65	0.63	<0.01
Flanker congruency x Stroop previous congruency	4, 88	0.67	0.61	<0.01	0.68	0.61	<0.01
Stroop congruency x Flanker congruency x Stroop previous congruency	8, 176	1.14	0.34	<0.01	2.01	0.05	0.02

Note. Effect sizes are expressed as generalized η^2 values. Uncorrected degrees of freedom are presented for better readability.

Experiment 1c: Means and standard deviations (in parentheses).

		Flanker	Flanker	Flanker	Stroop	Stroop	Stroop
		previous	previous	previous	previous	previous	previous
Dependent measures and trial types		incongruent	neutral	congruent	incongruent	neutral	congruent
<i>Reaction times</i>							
Stroop incongruent	Flanker incongruent	938 (182)	936 (159)	961 (171)	926 (171)	974 (151)	945 (159)
	Flanker neutral	901 (199)	933 (122)	933 (114)	937 (146)	922 (149)	935 (113)
	Flanker congruent	988 (209)	1019 (148)	1003 (180)	997 (163)	1008 (162)	986 (192)
Stroop neutral	Flanker incongruent	779 (169)	816 (134)	835 (100)	834 (109)	805 (130)	831 (102)
	Flanker neutral	813 (145)	835 (111)	842 (135)	850 (164)	832 (148)	808 (96)
	Flanker congruent	801 (145)	795 (129)	779 (123)	790 (136)	801 (186)	798 (108)
Stroop congruent	Flanker incongruent	781 (112)	791 (115)	773 (136)	800 (110)	764 (115)	782 (111)
	Flanker neutral	765 (108)	779 (169)	805 (140)	796 (132)	799 (162)	765 (117)
	Flanker congruent	747 (140)	762 (138)	740 (115)	754 (125)	741 (133)	757 (128)
<i>Accuracy</i>							

		Flanker	Flanker	Flanker	Stroop	Stroop	Stroop
		previous	previous	previous	previous	previous	previous
Dependent measures and trial types		incongruent	neutral	congruent	incongruent	neutral	congruent
Stroop incongruent	Flanker incongruent	0.91 (0.08)	0.92 (0.06)	0.92 (0.06)	0.91 (0.08)	0.92 (0.06)	0.92 (0.06)
	Flanker neutral	0.90 (0.09)	0.94 (0.05)	0.95 (0.09)	0.90 (0.09)	0.94 (0.05)	0.95 (0.09)
	Flanker congruent	0.94 (0.07)	0.91 (0.08)	0.92 (0.07)	0.94 (0.07)	0.91 (0.08)	0.92 (0.07)
Stroop neutral	Flanker incongruent	0.95 (0.05)	0.96 (0.04)	0.96 (0.04)	0.95 (0.05)	0.96 (0.04)	0.96 (0.04)
	Flanker neutral	0.96 (0.05)	0.97 (0.04)	0.95 (0.06)	0.96 (0.05)	0.97 (0.04)	0.95 (0.06)
	Flanker congruent	0.95 (0.06)	0.95 (0.05)	0.96 (0.05)	0.95 (0.06)	0.95 (0.05)	0.96 (0.05)
Stroop congruent	Flanker incongruent	0.98 (0.04)	0.96 (0.05)	0.97 (0.05)	0.98 (0.04)	0.96 (0.05)	0.97 (0.05)
	Flanker neutral	0.97 (0.04)	0.97 (0.04)	0.97 (0.05)	0.97 (0.04)	0.97 (0.04)	0.97 (0.05)
	Flanker congruent	0.97 (0.03)	0.98 (0.04)	0.98 (0.02)	0.97 (0.03)	0.98 (0.04)	0.98 (0.02)

Table 10

Experiment 2: Inferential statistical values for the 3-way repeated-measures analysis of variance (ANOVA) with the factors Stroop congruency (incongruent, congruent), Simon congruency (incongruent, congruent), and Simon previous congruency (incongruent, congruent).

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Stroop congruency	1, 22	78.81	<0.001	0.22	19.96	<0.001	0.05
Simon congruency	1, 22	28.94	<0.001	0.01	0.00	0.98	<0.01
Simon previous congruency	1, 22	0.11	0.75	<0.01	0.52	0.48	<0.01
Stroop congruency x Simon congruency	1, 22	6.11	0.02	<0.01	3.90	0.06	0.02
Stroop congruency x Simon previous congruency	1, 22	0.13	0.72	<0.01	0.58	0.45	<0.01
Simon congruency x Simon previous congruency	1, 22	0.04	0.84	<0.01	1.66	0.21	<0.01
three-way interaction	1, 22	0.74	0.40	<0.01	0.44	0.51	<0.01

Note. Effect sizes are expressed as generalized η^2 values.

Table 11

Experiment 2: Inferential statistical values for the 3-way repeated-measures analysis of variance (ANOVA) with the factors Stroop congruency (incongruent, congruent), Simon congruency (incongruent, congruent), and Stroop previous congruency (incongruent, congruent).

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Stroop congruency	1, 22	72.44	<0.001	0.21	20.43	<0.001	0.05
Simon congruency	1, 22	26.8	<0.001	0.01	0.02	0.9	<0.01
Stroop previous congruency	1, 22	0.28	0.60	<0.01	0.91	0.35	<0.01
Stroop congruency x Simon congruency	1, 22	8.92	<0.01	<0.01	3.94	0.06	0.02
Stroop congruency x Stroop previous congruency	1, 22	8.82	<0.01	<0.01	1.64	0.21	<0.01
Simon congruency x Stroop previous congruency	1, 22	0.00	0.98	<0.01	0.70	0.41	<0.01
three-way interaction	1, 22	1.49	0.24	<0.01	2.59	0.12	<0.01

Note. Effect sizes are expressed as generalized η^2 values.

Table 12

Experiment 2: Means and standard deviations (in parentheses).

		Simon	Simon	Stroop	Stroop
Dependent measures and trial types		previous incongruent	previous congruent	previous incongruent	previous congruent
<i>Reaction times</i>					
Stroop incongruent	Simon incongruent	1104 (254)	1107 (234)	1130 (227)	1072 (247)
	Simon congruent	1103 (212)	1083 (223)	1071 (241)	1104 (206)
Stroop congruent	Simon incongruent	928 (164)	921 (184)	952 (197)	906 (151)
	Simon congruent	846 (190)	854 (157)	858 (181)	834 (165)
<i>Accuracy</i>					
Stroop incongruent	Simon incongruent	0.93 (0.05)	0.93 (0.06)	0.93 (0.07)	0.93 (0.05)
	Simon congruent	0.90 (0.10)	0.92 (0.11)	0.92 (0.09)	0.90 (0.11)
Stroop congruent	Simon incongruent	0.94 (0.09)	0.94 (0.08)	0.95 (0.09)	0.94 (0.08)
	Simon congruent	0.97 (0.03)	0.97 (0.04)	0.97 (0.04)	0.97 (0.03)

Table 13

Experiment 3: Inferential statistical values for the 4-way repeated-measures analysis of variance (ANOVA) with the factors Flanker congruency (incongruent, congruent), Simon congruency (incongruent, congruent), Flanker previous congruency (incongruent, congruent), and Simon previous congruency (incongruent, congruent).

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Flanker congruency	1, 23	262.73	<0.001	0.16	6.81	0.02	0.01
Simon congruency	1, 23	28.6	<0.001	0.02	15.66	<0.001	0.04
Flanker previous congruency	1, 23	5.56	0.03	<0.01	0.55	0.47	<0.01
Simon previous congruency	1, 23	2.66	0.12	<0.01	0.04	0.85	<0.01
Flanker congruency x Simon congruency	1, 23	16.52	<0.001	<0.01	1.04	0.32	<0.01
Flanker congruency x Flanker previous congruency	1, 23	81.4	<0.001	0.04	3.88	0.06	<0.01
Simon congruency x Flanker previous congruency	1, 23	0.41	0.53	<0.01	2.38	0.14	<0.01
Flanker congruency x Simon previous congruency	1, 23	2.10	0.16	<0.01	1.09	0.31	<0.01
Simon congruency x Simon previous congruency	1, 23	36.53	<0.001	0.02	5.10	0.03	<0.01
Simon previous congruency x Flanker previous congruency	1, 23	0.06	0.81	<0.01	0.53	0.47	<0.01

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
Simon congruency x Flanker congruency x Flanker previous congruency	1, 23	0.49	0.49	<0.01	1.49	0.24	<0.01
Simon congruency x Flanker congruency x Simon previous congruency	1, 23	0.06	0.81	<0.01	0.20	0.66	<0.01
Flanker congruency x Flanker previous congruency x Simon previous congruency	1, 23	0.06	0.81	<0.01	0.01	0.92	<0.01
Simon congruency x Flanker previous congruency x Simon previous congruency	1, 23	0.06	0.82	<0.01	0.32	0.58	<0.01
four-way interaction	1, 23	0.06	0.80	<0.01	0.36	0.56	<0.01

Note. Effect sizes are expressed as generalized η^2 values.

Table 14

Experiment 3: Means and standard deviations (in parentheses).

		Simon previous incongruent		Simon previous congruent	
		Flanker	Flanker	Flanker	Flanker
Dependent measures and trial types		previous incongruent	previous congruent	previous incongruent	previous congruent
<i>Reaction times</i>					
Simon incongruent	Flanker incongruent	824 (91)	855 (89)	837 (88)	871 (102)
	Flanker congruent	790 (90)	740 (88)	813 (87)	767 (89)
Simon congruent	Flanker incongruent	841 (120)	862 (112)	804 (93)	828 (89)
	Flanker congruent	777 (99)	730 (86)	812 (146)	699 (92)
<i>Accuracy</i>					
Simon incongruent	Flanker incongruent	0.94 (0.04)	0.93 (0.04)	0.94 (0.04)	0.93 (0.05)
	Flanker congruent	0.94 (0.04)	0.94 (0.04)	0.94 (0.04)	0.93 (0.04)
Simon congruent	Flanker incongruent	0.95 (0.04)	0.94 (0.04)	0.96 (0.03)	0.95 (0.04)
	Flanker congruent	0.95 (0.05)	0.96 (0.03)	0.96 (0.04)	0.97 (0.03)

B

Block Type	Stimulus	Position	Type	Frequency
Stimulus-response mapping block	xxxx	centrally	-	-
Pure Stroop block	white	centrally	Stroop incongruent	50%
	red	centrally	Stroop congruent	50%
Pure Flanker block	eeee	centrally	Flanker incongruent	50%
	eeee	centrally	Flanker congruent	50%
Mixed block	white	centrally	Stroop incongruent, Flanker incongruent	25%
	white	centrally	Stroop incongruent, Flanker congruent	25%
	red	centrally	Stroop congruent, Flanker incongruent	25%
	red	centrally	Stroop congruent, Flanker congruent	25%

Figure 1. Experiment 1a. (A) Example of one trial sequence in the mixed block. In this block type, participants were asked to indicate the color of the letter in the middle while ignoring the meaning of the word and the color of the flanking letters. (B) Example of stimuli for each block type and trial type with the respective frequencies.

Figure 2. Experiment 1a: Modulation of the Stroop congruency effect by Flanker congruency within a trial. Mean reaction times (RT) for both Stroop and Flanker congruency. Error bars represent within-subject confidence intervals (see Cousineau, 2005; Morey, 2008).

Figure 3. Experiment 1b: Modulation of the Stroop congruency effect by Flanker congruency within a trial. Mean reaction times (RT) for both Stroop and Flanker congruency. Error bars represent within-subject confidence intervals (see Cousineau, 2005; Morey, 2008).

Figure 4. Experiment 1c: Modulation of the Stroop congruency effect by Flanker congruency within a trial. Mean reaction times (RT) for both Stroop and Flanker congruency. Error bars represent within-subject confidence intervals (see Cousineau, 2005; Morey, 2008).

B

Block Type	Stimulus	Position	Type	Frequency
Stimulus-response mapping block	xxxx	centrally	-	-
Pure Stroop block	white	centrally	Stroop incongruent	50%
	red	centrally	Stroop congruent	50%
Pure Simon block	****	lower right	Simon incongruent	50%
	****	upper left	Simon congruent	50%
Mixed block	white	lower left	Stroop incongruent, Simon incongruent	25%
	white	upper left	Stroop incongruent, Simon congruent	25%
	red	lower left	Stroop congruent, Simon incongruent	25%
	red	upper left	Stroop congruent, Simon congruent	25%

Figure 5. Experiment 2. (A) Example of one trial sequence in the mixed block. In this block type, participants were asked to indicate the print color of the color word while ignoring the meaning of the word and its position on the screen. (B) Example of stimuli for each block type and trial type with the respective frequencies.

Figure 6. Experiment 2: Modulation of the Stroop congruency effect by Simon congruency within a trial. Mean reaction times (RT) for both Stroop and Simon congruency. Error bars represent within-subject confidence intervals (see Cousineau, 2005; Morey, 2008).

Figure 7. Experiment 3. (A) Example of one trial sequence in the mixed block. In this block type, participants were asked to indicate the color of the central letter while ignoring the color of the flanking letters and the position of the letters’ row on the screen. (B) Example of stimuli for each block type and trial type with the respective frequencies.

Figure 8. Experiment 3: Modulation of the Flanker congruency effect by Simon congruency within a trial. Mean reaction times (RT) for both Flanker and Simon congruency. Error bars represent within-subject confidence intervals (see Cousineau, 2005; Morey, 2008).

Appendix A

Performance on catch trials

For all experiments including catch trials (i.e., Experiments 1a, 1b, 1c, and 2), data trimming on catch trials removed errors. We excluded RT faster than 3 Standard Deviations (SD) from the mean and slower than 3 SDs from the mean. Feature repetitions were not removed as there would have resulted in too less observations. This removed 8.6%, 8.7%, 10.2% and 10.9% of the trials in Experiments 1a, 1b, 1c and 2, respectively. An alpha level of 0.05 was used for all statistical tests. Effect sizes are expressed as generalized η_g^2 values.

Experiment 1a

Mixed blocks. We first investigated performance on catch trials in mixed blocks. To this end, we conducted a two-way repeated-measures analysis of variance (ANOVA) with the factors Stroop congruency (incongruent, congruent) and Flanker congruency (incongruent, congruent). This ANOVA revealed a significant main effect of Stroop congruency, $F(1, 23) = 56.47, p < .001, \eta_g^2 = .06$, and of Flanker congruency, $F(1, 23) = 74.44, p < .001, \eta_g^2 = .14$, as well as a significant interaction, $F(1, 23) = 4.49, p < .05, \eta_g^2 < .01$. This interaction results from a smaller Stroop congruency effect when Flanker trials were incongruent (72 ms), $t(23) = 4.02, p < .001$, compared to when they were congruent (128 ms), $t(23) = 7.29, p < .001$. Thus, even in catch trials, Flanker congruency modulates the Stroop congruency effect (see Figure A1, Panel A).

The same ANOVA on accuracy data revealed a significant main effect of Stroop congruency, $F(1, 23) = 26.05, p < .001, \eta_g^2 = .27$, and of Flanker congruency, $F(1, 23) = 12.78, p < .01, \eta_g^2 = .02$, as well as a significant interaction, $F(1, 23) = 6.11, p < .05, \eta_g^2 = .02$. Thus, the Stroop congruency effect in the accuracy data was larger when Flanker trials were incongruent ($M = .87, SD = 0.08$, and $M = .98, SD = 0.06$, for Stroop incongruent and congruent

trials, respectively), $t(22) = 3.34, p < .001$, compared to when they were congruent ($M = .91, SD = 0.04$, and $M = .98, SD = 0.05$, for Stroop incongruent and congruent trials, respectively), $t(22) = 4.17, p < .001$. Thus, a speed-accuracy trade-off compromised the critical RTs effects.

Pure Stroop blocks. We examined catch trials in pure Stroop blocks by comparing congruent and incongruent trials with a t -test. For RTs, the results showed slower performance for incongruent trials than for congruent trials ($M = 1355, SD = 96$, and $M = 1125$ ms, $SD = 96$, respectively), $t(23) = 8.27, p < .001$. For accuracy data, the results showed lower performance for incongruent trials than for congruent trials ($M = .87, SD = 0.09$, and $M = .98, SD = 0.09$, respectively), $t(23) = 4.38, p < .001$. This indicates a Stroop congruency effect in RT and accuracy data in catch trials.

Experiment 1b

Mixed blocks. Similarly to Experiment 1a, we ran for Experiment 1b a two-way ANOVA with the factors Stroop congruency (incongruent, congruent) and Flanker congruency (incongruent, congruent). This ANOVA revealed a significant main effect of Stroop congruency, $F(1, 26) = 59.15, p < .001, \eta_g^2 = .03$, and of Flanker congruency, $F(1, 26) = 15.22, p < .001, \eta_g^2 = .10$, as well as a significant interaction, $F(1, 26) = 15.62, p < .001, \eta_g^2 < .02$. This interaction results from a smaller Stroop congruency effect when Flanker trials were incongruent (63 ms), $t(26) = 3.04, p < .001$, compared to when they were congruent (170 ms), $t(26) = 8.53, p < .001$. Thus, similarly to Experiment 1a, Flanker congruency modulates the Stroop congruency effect in catch trials (see Figure A1, Panel B).

The same ANOVA on accuracy data revealed a significant main effect of Stroop congruency, $F(1, 26) = 44.68, p < .001, \eta_g^2 = .26$. Thus, the Stroop congruency effect was observed in catch trials ($M = .91, SD = 0.08$, and $M = .96, SD = 0.04$, for Stroop incongruent and

congruent trials, respectively). However, neither the main effect of Flanker congruency, $F(1, 26) = 3.81, p = .06, \eta_g^2 = .02$, nor the interaction, $F(1, 26) = 1.56, p = .22, \eta_g^2 < .001$, were significant. Thus, in contrast to Experiment 1a, no speed accuracy trade-off was observed for catch trials.

Pure Stroop blocks. We examined catch trials in pure Stroop blocks by comparing congruent and incongruent trials with a t -test. For RTs, the results showed slower performance for incongruent trials than for congruent trials ($M = 1329, SD = 261$, and $M = 1082$ ms, $SD = 229$, respectively), $t(26) = 9.33, p < .001$. For accuracy data, the results showed lower performance for incongruent trials than for congruent trials ($M = .82, SD = 0.03$, and $M = .98, SD = 0.1$, respectively), $t(23) = 8.73, p < .001$. This indicates a Stroop congruency effect in RT and accuracy data in catch trials as for Experiment 1b.

Experiment 1c

Mixed blocks. In Experiment 1c, we conducted a 2-way ANOVA with the factors Stroop congruency (incongruent, congruent, neutral) and Flanker congruency (incongruent, congruent, neutral). Please note that we report uncorrected degrees of freedom for better readability.

This ANOVA revealed a significant main effect of Stroop congruency, $F(2, 44) = 64.01, p < .001, \eta_g^2 = .01$, and of Flanker congruency, $F(2, 44) = 14.33, p < .001, \eta_g^2 = .03$, as well as a significant interaction, $F(4, 88) = 2.93, p < .05, \eta_g^2 < .001$. When the Stroop congruency effect was computed as the difference between incongruent and congruent trials, it was smaller for Flanker incongruent trials (100 ms), $t(22) = 4.54, p < .001$, than for Flanker congruent trials (158 ms), $t(22) = 8.59, p < .001$, or neutral (166 ms), $t(22) = 6.85, p < .001$. When the Stroop congruency effect was computed as the difference between incongruent and neutral trials, it was not significant for Flanker incongruent trials (-16 ms), $t(22) < 1$, but significant for Flanker

congruent trials (50 ms), $t(22) = 3.2, p < .01$, or Flanker neutral trials (62 ms), $t(22) = 2.9, p < .01$. Thus, Flanker congruency again modulates the Stroop congruency effect in catch trials (see Figure A1, Panel C).

The same ANOVA on accuracy data revealed a significant main effect of Stroop congruency, $F(2, 44) = 34.21, p < .001, \eta_g^2 = .22$. Thus, a Stroop congruency effect was observed in catch trials ($M = .87, SD = 0.10, M = .97, SD = 0.06$, and $M = .89, SD = .09$, for Stroop incongruent, congruent and neutral trials, respectively). However, neither the main effect of Flanker congruency, $F(2, 44) = 12.02, p = .06, \eta_g^2 = .004$, nor the interaction, $F(4, 88) = 1.84, p = .13, \eta_g^2 = .001$, were significant. Thus, no speed-accuracy tradeoff was observed.

Pure Stroop blocks. We examined catch trials in pure Stroop blocks by running a one-way repeated-measures ANOVA with the factor congruency (incongruent, congruent, neutral). This analysis yielded a significant effect of congruency, $F(1, 23) = 23.18, p < .001$. Follow-up t -tests revealed a significant Stroop congruency effect when this was computed as the difference between incongruent and congruent trials ($M = 1201, SD = 176$, and $M = 1020$ ms, $SD = 189$, respectively), $t(23) = 7.01, p < .001$, as well as when it was between incongruent and neutral trials ($M = 1201, SD = 176$, and $M = 1135$ ms, $SD = 208$, respectively), $t(23) = 2.58, p < .016$.

The same ANOVA on accuracy data yielded a significant effect of congruency, $F(1, 23) = 5.28, p < .01$. Follow-up t -tests revealed a significant Stroop congruency effect when this was computed as the difference between incongruent and congruent trials ($M = .83, SD = 0.03$, and $M = .98, SD = 0.09$, respectively), $t(23) = 9.08, p < .001$, as well as it was between incongruent and neutral trials ($M = .83, SD = 0.03$, and $M = .90, SD = 0.07$, respectively), $t(23) = 3.34, p < .01$.

Experiment 2

Mixed blocks. We first conducted a two-way repeated-measures ANOVA with the factors Stroop congruency (incongruent, congruent) and Simon congruency (incongruent, congruent). This ANOVA revealed a significant main effect of Stroop congruency, $F(1, 22) = 76.5, p < .001, \eta_g^2 = .16$, but no main effect of Simon congruency, $F(1, 22) = 0.2, p = .66, \eta_g^2 = .01$. The interaction was, however, significant, $F(1, 22) = 4.74, p < .05, \eta_g^2 = .01$. This interaction results from a smaller Stroop congruency effect when Simon trials were incongruent (172 ms), $t(22) = 6.97, p < .001$, compared to when they were congruent (241 ms), $t(22) = 7.6, p < .001$. Thus, even in catch trials, Simon congruency modulates the Stroop congruency effect (see Figure A1, Panel D).

The same ANOVA on accuracy data only revealed a significant main effect of Stroop congruency, $F(1, 22) = 28.8, p < .001, \eta_g^2 = .27$. Participants were less correct on Stroop incongruent trials than on Stroop congruent trials ($M = .85, SD = 0.08$, and $M = .97, SD = 0.08$, respectively). This indicates a Stroop congruency effect for the accuracy data.

Pure Stroop blocks. We examined catch trials in pure Stroop blocks by comparing congruent and incongruent trials with a t -test. For RTs, the results showed slower performance for incongruent trials than for congruent trials ($M = 1317, SD = 104$, and $M = 1088$ ms, $SD = 104$, respectively), $t(22) = 7.44, p < .001$. For accuracy data, the results showed lower performance for incongruent trials than for congruent trials ($M = .85, SD = 0.06$, and $M = .96, SD = 0.06$, respectively), $t(22) = 6.27, p < .001$. This indicates a Stroop congruency effect in RT and accuracy data even in catch trials.

Figure A1. (A, B, C) Modulation of the Stroop congruency effect by Flanker congruency in catch trials. Mean reaction times (RT) for Stroop and Flanker congruency in Experiment 1a (A), in Experiment 1b (B) and in Experiment 1c (C). (D) Modulation of the Stroop congruency effect by Simon congruency in catch trials. Mean reaction times (RT) for Stroop and Simon congruency in Experiment 2. Error bars represent within-subject confidence intervals (see Cousineau, 2005; Morey, 2008).

Appendix B

Analyses on pure blocks

Table B1

Experiment 1a: Inferential statistical values for the two-way repeated-measures analysis of variance (ANOVA) with the factors congruency (incongruent, congruent) and previous congruency (incongruent, congruent) for the pure Stroop and Flanker blocks, respectively.

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_{g}^2	<i>F</i>	<i>p</i>	η_{g}^2
<i>Pure Stroop blocks</i>							
Congruency	1, 23	83.68	<0.001	0.25	58.72	<0.001	0.35
Previous congruency	1, 23	8.75	<0.01	0.01	6.13	0.02	0.03
Two-way interaction	1, 23	11.96	<0.01	0.02	11.45	<0.01	0.04
<i>Pure Flanker blocks</i>							
Congruency	1, 23	8.55	<0.01	0.01	4.13	0.05	0.01
Previous congruency	1, 23	0.02	0.90	<0.01	0.53	0.48	<0.01
Two-way interaction	1, 23	0.06	0.81	<0.01	1.03	0.32	<0.01

Note. Effect sizes are expressed as generalized η^2 values.

Table B2

Experiment 1a: Means and standard deviations (in parentheses) for the pure Stroop and Flanker blocks.

Dependent measures and trial types	Pure Stroop blocks		Pure Flanker blocks	
	Previous incongruent	Previous congruent	Previous incongruent	Previous congruent
<i>Reaction times</i>				
Incongruent	1019 (185)	1108 (186)	692 (100)	694 (90)
Congruent	870 (171)	857 (157)	674 (93)	673 (101)
<i>Accuracy</i>				
Incongruent	0.93 (0.06)	0.89 (0.07)	0.97 (0.03)	0.97 (0.02)
Congruent	0.98 (0.03)	0.98 (0.03)	0.97 (0.03)	0.96 (0.03)

Table B3

Experiment 1b: Inferential statistical values for the two-way repeated-measures analysis of variance (ANOVA) with the factors congruency (incongruent, congruent) and previous congruency (incongruent, congruent) for the pure Stroop and Flanker blocks, respectively.

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
<i>Pure Stroop blocks</i>							
Congruency	1, 26	102.76	<0.001	0.14	28.40	<0.001	0.15
Previous congruency	1, 26	14.38	<0.001	0.01	1.38	0.25	0.01
Two-way interaction	1, 26	14.31	<0.001	0.02	8.48	<0.01	0.04
<i>Pure Flanker blocks</i>							
Congruency	1, 26	17.40	<0.001	0.01	0.86	0.36	<0.01
Previous congruency	1, 26	1.61	0.22	<0.01	0.37	0.55	<0.01
Two-way interaction	1, 26	2.10	0.16	<0.01	0.00	0.97	<0.01

Note. Effect sizes are expressed as generalized η^2 values.

Table B4

Experiment 1b: Means and standard deviations (in parentheses) for the pure Stroop and Flanker blocks.

Dependent measures and trial types	Pure Stroop blocks		Pure Flanker blocks	
	Previous incongruent	Previous congruent	Previous incongruent	Previous congruent
<i>Reaction times</i>				
Incongruent	884 (175)	796 (175)	729 (123)	723 (125)
Congruent	973 (181)	778 (171)	700 (110)	695 (119)
<i>Accuracy</i>				
Incongruent	0.95 (0.03)	0.97 (0.03)	0.96 (0.03)	0.97 (0.03)
Congruent	0.93 (0.05)	0.97 (0.04)	0.96 (0.03)	0.96 (0.03)

Table B5

Experiment 1c: Inferential statistical values for the two-way repeated-measures analysis of variance (ANOVA) with the factors congruency (incongruent, congruent, neutral) and previous congruency (incongruent, congruent, neutral) for the pure Stroop and Flanker blocks, respectively.

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_{g}^2	<i>F</i>	<i>p</i>	η_{g}^2
<i>Pure Stroop blocks</i>							
Congruency	2, 46	35.57	<0.001	0.18	17.95	<0.001	0.15
Previous congruency	2, 46	6.40	<0.01	0.01	1.14	0.33	<0.01
Two-way interaction	4, 92	1.50	0.21	<0.01	0.25	0.91	<0.01
<i>Pure Flanker blocks</i>							
Congruency	2, 46	5.20	<0.01	0.01	0.46	0.63	<0.01
Previous congruency	2, 46	0.68	0.51	<0.01	1.51	0.23	<0.01
Two-way interaction	4, 92	2.67	0.04	<0.01	0.89	0.47	<0.01

Note. Effect sizes are expressed as generalized η^2 values. Please note that uncorrected degrees of freedom are presented for better readability.

Table B6

Experiment 1c: Means and standard deviations (in parentheses) for the pure Stroop and Flanker blocks.

Dependent measures and trial types	Pure Stroop blocks				Pure Flanker blocks	
	Previous incongruent	Previous neutral	Previous congruent	Previous incongruent	Previous neutral	Previous congruent
<i>Reaction times</i>						
Incongruent	1019 (185)	1011 (238)	934 (213)	656 (77)	669 (72)	675 (84)
Neutral	794 (156)	800 (182)	793 (161)	679 (84)	675 (78)	669 (78)
Congruent	777 (186)	820 (173)	788 (164)	666 (88)	657 (70)	642 (65)
<i>Accuracy</i>						
Incongruent	0.93 (0.07)	0.91 (0.08)	0.91 (0.08)	0.95 (0.05)	0.96 (0.05)	0.96 (0.04)
Neutral	0.96 (0.05)	0.96 (0.05)	0.95 (0.06)	0.96 (0.04)	0.96 (0.04)	0.95 (0.06)
Congruent	0.98 (0.03)	0.97 (0.05)	0.97 (0.05)	0.95 (0.04)	0.96 (0.05)	0.97 (0.04)

Table B7

Experiment 2: Inferential statistical values for the two-way repeated-measures analysis of variance (ANOVA) with the factors congruency (incongruent, congruent) and previous congruency (incongruent, congruent) for the pure Stroop and Simon blocks, respectively.

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
<i>Pure Stroop blocks</i>							
Congruency	1, 22	88.45	<0.001	0.27	43.56	<0.001	0.11
Previous congruency	1, 22	0.68	0.42	<0.01	4.82	0.04	0.01
Two-way interaction	1, 22	2.84	0.11	<0.01	0.46	0.51	<0.01
<i>Pure Simon blocks</i>							
Congruency	1, 22	37.65	<0.001	0.06	15.81	<0.001	0.05
Previous congruency	1, 22	0.86	0.36	<0.01	0.11	0.74	<0.01
Two-way interaction	1, 22	4.26	0.05	<0.01	10.18	<0.01	<0.01

Note. Effect sizes are expressed as generalized η^2 values.

Table B8

Experiment 2: Means and standard deviations (in parentheses) for the pure Stroop and Simon blocks.

Dependent measures and trial types	Pure Stroop blocks		Pure Simon blocks	
	Previous incongruent	Previous congruent	Previous incongruent	Previous congruent
<i>Reaction times</i>				
Incongruent	979 (200)	1011 (199)	857 (121)	886 (132)
Congruent	775 (171)	789 (140)	807 (148)	798 (145)
<i>Accuracy</i>				
Incongruent	0.92 (0.08)	0.89 (0.10)	0.90 (0.11)	0.89 (0.11)
Congruent	0.96 (0.08)	0.95 (0.06)	0.94 (0.08)	0.95 (0.08)

Table B9

Experiment 3: Inferential statistical values for the two-way repeated-measures analysis of variance (ANOVA) with the factors congruency (incongruent, congruent) and previous congruency (incongruent, congruent) for the pure Flanker and Simon blocks, respectively.

Effect	<i>df</i>	Reaction times			Accuracy		
		<i>F</i>	<i>p</i>	η_g^2	<i>F</i>	<i>p</i>	η_g^2
<i>Pure Flanker blocks</i>							
Congruency	1, 23	19.52	<0.001	0.04	0.14	0.71	<0.01
Previous congruency	1, 23	0.19	0.66	<0.01	0.79	0.38	<0.01
Two-way interaction	1, 23	1.75	0.20	<0.01	1.18	0.29	<0.01
<i>Pure Simon blocks</i>							
Congruency	1, 23	64.76	<0.001	0.12	28.98	<0.001	0.2
Previous congruency	1, 23	1.28	0.27	<0.01	0.00	1.00	<0.01
Two-way interaction	1, 23	2.94	0.10	<0.01	19.68	<0.001	0.06

Note. Effect sizes are expressed as generalized η^2 values.

Table B10

Experiment 3: Means and standard deviations (in parentheses) for the pure Flanker and Simon blocks.

Dependent measures and trial types	Pure Flanker blocks		Pure Simon blocks	
	Previous incongruent	Previous congruent	Previous incongruent	Previous congruent
<i>Reaction times</i>				
Incongruent	793 (97)	815 (122)	792 (97)	814 (119)
Congruent	733 (93)	728 (99)	733 (93)	728 (99)
<i>Accuracy</i>				
Incongruent	0.93 (0.05)	0.91 (0.05)	0.93 (0.05)	0.91 (0.05)
Congruent	0.95 (0.03)	0.97 (0.02)	0.95 (0.03)	0.97 (0.02)

Appendix C

Analyses on quantile data

Data preparation was similar to Experiment 1a, except that individual mean reaction times (RTs) quintiles were computed for the 1st to 5th fifth of the rank-ordered raw data for each trial type (Hommel, 1997). Then, for Experiments 1a, 1b, 2 and 3, we carried out a three-way repeated-measures analysis of variance (ANOVA) with the factors congruency of the first task (incongruent, congruent), congruency of the second task (incongruent, congruent), and quintile (1st, 2nd, 3rd, 4th, 5th). For the Experiment 1c, we also carried out a three-way repeated-measures ANOVA but with the factors Stroop congruency (incongruent, congruent, neutral), Flanker congruency (incongruent, congruent, neutral), and quintile (1st, 2nd, 3rd, 4th, 5th). Please note that in order to have enough data points per cell, we omitted the congruency of the previous trial in the analyses.

Descriptive results are presented in the Figure C1. Statistical results are presented in Table C1. In all experiments (except Experiment 1b), the quintile factor was not involved in the three-way interaction. Therefore, all statistical effects of such analyses are identical to those of the ANOVAs presented in the main text. Only in Experiment 1b was the three-way interaction significant. Follow-up two-way repeated-measures ANOVA with Stroop congruency (incongruent, congruent) and Flanker congruency (incongruent, congruent) revealed, however, a significant interaction between Stroop and Flanker congruency for all quintiles (1st quintile: $F(1, 26) = 5.53, p < .05, \eta_g^2 = .01$; 2nd quintile: $F(1, 26) = 11.78, p < .001, \eta_g^2 = .01$; 3rd quintile: $F(1, 26) = 11.51, p < .001, \eta_g^2 = .01$; 4th quintile: $F(1, 26) = 9.56, p < .001, \eta_g^2 = .01$; 5th quintile: $F(1, 26) = 16.6, p < .001, \eta_g^2 = .01$). Thus, only the magnitude

of the within-trial congruency interaction changes across the quintiles (see Figure C1). Together, the present analyses result in similar findings as those presented in the main text.

Table C1

Inferential statistical values for the three-way repeated-measures analysis of variance (ANOVA).

Effect	<i>df</i>	<i>F</i>	<i>p</i>	η_g^2
<i>Experiment 1a</i>				
Stroop congruency	1, 23	149.63	< 0.001	0.24
Flanker congruency	1, 23	11.11	< 0.01	< 0.01
quintile	4, 92	505.98	< 0.001	0.72
Stroop congruency x Flanker congruency	1, 23	5.15	< 0.05	< 0.01
Stroop congruency x quintile	4, 92	28.14	< 0.001	< 0.05
Flanker congruency x quintile	4, 92	0.71	0.49	< 0.001
3-way interaction	4, 92	2.42	0.10	< 0.01
<i>Experiment 1b</i>				
Stroop congruency	1, 26	305.44	< 0.001	0.13
Flanker congruency	1, 26	12.93	< 0.01	< 0.05
quintile	4, 104	329.18	< 0.001	0.66
Stroop congruency x Flanker congruency	1, 26	17.30	< 0.001	< 0.01
Stroop congruency x quintile	4, 104	44.14	< 0.001	< 0.05
Flanker congruency x quintile	4, 104	5.27	< 0.01	< 0.01
3-way interaction	4, 104	6.02	< 0.01	< 0.01
<i>Experiment 1c</i>				
Stroop congruency	2, 44	153.82	< 0.001	0.23
Flanker congruency	2, 44	8.82	< 0.01	< 0.01

Effect	<i>df</i>	<i>F</i>	<i>p</i>	η_g^2
quintile	4, 88	443.32	< 0.001	0.72
Stroop congruency x Flanker congruency	4, 88	7.83	< 0.001	< 0.05
Stroop congruency x quintile	8, 176	29.48	< 0.001	< 0.05
Flanker congruency x quintile	8, 176	1.26	0.30	< 0.01
3-way interaction	16, 352	1.30	0.27	< 0.01
<i>Experiment 2</i>				
Stroop congruency	1, 22	128.58	< 0.001	0.20
Simon congruency	1, 22	3.65	0.07	< 0.01
quintile	4, 88	273.53	< 0.001	0.67
Stroop congruency x Simon congruency	1, 22	18.89	< 0.001	< 0.05
Stroop congruency x quintile	4, 88	36.35	< 0.001	< 0.05
Simon congruency x quintile	4, 88	1.37	0.26	< 0.001
3-way interaction	4, 88	0.77	0.45	< 0.001
<i>Experiment 3</i>				
Flanker congruency	1, 23	161.69	< 0.001	0.11
Simon congruency	1, 23	35.90	< 0.001	< 0.05
quintile	4, 92	257.35	< 0.001	0.71
Flanker congruency x Simon congruency	1, 23	17.57	< 0.001	< 0.01
Flanker congruency x quintile	4, 92	0.83	0.42	< 0.001
Simon congruency x quintile	4, 92	1.01	0.37	< 0.001
3-way interaction	4, 92	0.81	0.43	< 0.001

Note. Effect sizes are expressed as generalized η^2 values. Please note that uncorrected degrees of freedom are presented for better readability.

Figure C1. Within-trial modulation of the congruency effect in one task by the congruency of the other task across the quintiles. Mean reaction times (RT) for the congruency of the first and second tasks across the five quintiles. Error bars represent within-subject confidence intervals (see Cousineau, 2005; Morey, 2008). (A) Experiment 1a. (B) Experiment 1b. (C) Experiment 1c. (D) Experiment 2. (E) Experiment 3.