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Different mechanisms can account for the instruction induced proportion congruency effect

Kobe Desender*

Department of Neurophysiology and Pathophysiology, University Medical Center Hamburg-Eppendorf, Germany
Department of Experimental Psychology, Ghent University, Belgium
Department of Psychology,Vrije Universiteit Brussel, Belgium

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ABSTRACT

When performing a conflict task, performance is typically worse on trials with conflict between two responses (i.e., incongruent trials) compared to when there is no conflict (i.e., congruent trials), a finding known as the congruency effect. The congruency effect is reduced when the proportion of incongruent trials is high, relative to when most of the trials are congruent (i.e., the proportion congruency effect). In the current work, it was tested whether different kinds of instructions can be used to induce a proportion congruency effect, while holding the actual proportion of congruent trials constant. Participants were instructed to strategically use the (invalid) information that most of the trials would be congruent versus incongruent, or they were told to adopt a liberal versus a conservative response threshold. All strategies effectively altered the size of the congruency effect relative to baseline, although in terms of statistical significance the effect was mostly limited to the error rates. A diffusion-model analysis of the data was partially consistent with the hypothesis that both types of instructions induced a proportion congruency effect by means of different underlying mechanisms.

1. Introduction

Cognitive control refers to the cognitive and neural mechanisms to deal with information that interferes with our plans and goals (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Verguts & Notebaert, 2009). For example, when a continental European drives a car in the United Kingdom, cognitive control mechanisms are needed to overrule the tendency to operate the traffic indicator with the left hand, thereby avoid hitting the wipers at every turn. One of the most influential approaches to experimentally study cognitive control, is to examine how humans adapt their behavior in the face of response conflict. This can be studied in conflict tasks where conflict is experimentally induced between two incompatible responses. For example, in the Simon task participants might be instructed to respond with the left hand to green stimuli and with the right hand to red stimuli, while ignoring the location where stimuli are presented (i.e., left or right from fixation; Simon & Rudell, 1967). Despite the instruction to ignore the location, reaction times are longer and error rates higher when the location of the stimulus is different from the response required by the color of the stimulus (i.e., when there is response conflict; incongruent trials), compared to when both trigger the same response (i.e., congruent trials). Thus, cognitive control mechanisms are required in this task to prevent oneself from responding to the location, and instead direct attention to the color. By varying the proportion of incongruent trials, it is possible to create conditions that differ in the need for cognitive control. When the majority of trials are incongruent, compared to congruent, the congruency effect is reduced, a finding known as the *proportion congruency effect* (Logan & Zbrodoff, 1979). This is one of the hallmark observations assumed to reflect an increase in cognitive control (e.g., Aben, Verguts, & Van den Bussche, 2017; Abrahamse, Duthoo, Notebaert, & Risko, 2013; Funes, Lupiáñez, & Humphreys, 2010).

The dominant interpretation of this effect is in terms of *conflict adaptation* (Botvinick, 2007; Botvinick et al., 2001). When conflict is detected between two responses, participants direct attention away from the irrelevant dimension. When most of the trials are incongruent (i.e., *mostly incongruent*), a sustained level of cognitive control is needed to suppress the location information. This is beneficial for incongruent trials, but it reduces the facilitative effect of location on the infrequent congruent trials, leading to reduced congruency effects. When the majority of trials are congruent (i.e., *mostly congruent*), a transient increase in cognitive control is sufficient to deal with the infrequent occurrence of response conflict. This strategy works well for congruent trials, but not for the few incongruent trials, and as a consequence the

* Corresponding author at: Department of Neurophysiology and Pathophysiology, University Medical Center Hamburg-Eppendorf, Martinistrasse 52, 20251 Hamburg, Germany.
E-mail address: Kobe.Desender@gmail.com.

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congruency effect will be large. This interpretation of the proportion congruency effect has recently been challenged. In particular, it has been argued that the effect might also be explained by contingency learning or episodic memory confounds (Schmidt & Besner, 2008). In a list with mostly incongruent trials, performance is better on incongruent trials and worse on congruent trials, compared to performance in a list with an equal number of both trials. However, the former list also contains much more incongruent trials overall, so performance on these trials might be better because participants are more frequently exposed to incongruent trials (Schmidt & Besner, 2008). More specifically, in a mostly incongruent block using the Simon task, stimuli appearing on the left are predictive of right hand responses, and vice versa.

In the current work, contingency learning and episodic memory confounds will be overcome by keeping the amount of response conflict constant, and instead manipulate participants' strategy. Previous work has already demonstrated that instructions might be sufficient to induce a proportion congruency effect (e.g., Bugg, Diede, Cohen-shikora, & Selmeczy, 2015; Bugg & Smallwood, 2016; Entel, Tzelgov, & Bereby-Meyer, 2014; Wühr & Kunde, 2008). However, the precise mechanisms by which participants implemented these instructions remain unclear. For example, in Entel et al. (2014), participants were informed that most of the trials would be congruent (or incongruent; depending on the group), but it was not explained how participants were to implement these instructions (the same is true for Bugg & Smallwood, 2016). Typically, it is assumed in such experiments that participants allocate attention to the relevant information depending on the proportion of congruent trials (Bugg & Smallwood, 2016; Wühr & Kunde, 2008). It could also be, however, that participants reasoned that a block with mostly congruent trials will be very easy, and thus that they could respond rapidly without the risk of making many errors. Under this scenario, instead of strategically allocating attention, participants adopt a liberal response threshold, providing a response with only a minimum of accumulated information. The counterpart of this strategy is that participants adopt a conservative response threshold (i.e., increased response caution), when they expect mostly incongruent trials. It has been shown that changes in the trade-off between speed and accuracy can indeed influence the size of the congruency effect (van Veen, Krug, & Carter, 2008). Given that strategically allocating attention and balancing between speed and accuracy are entirely different mechanisms, it is important to unravel whether both strategies can indeed be used to induce a proportion congruency effect. Moreover, it is crucial to demonstrate that both strategies induce a proportion congruency effect by means of different underlying mechanisms.

Although strategically allocating attention and balancing between speed and accuracy are different strategies, they are difficult to dissociate because both make similar behavioral predictions (i.e., a proportion congruency effect). Using cognitive modelling it might be possible to examine the underlying mechanisms of both strategies (Voss, Nagler, & Lerche, 2013). A rich literature exists explaining two-choice decisions as resulting from the accumulation of evidence for both response options (Gold & Shadlen, 2007). In the drift-diffusion model, it is assumed that the decision whether perceptual input belongs to either of two categories is done by comparing the evidence accumulated in favor of each alternative (Ratcliff & McKoon, 2008). Once the difference in accumulated evidence reaches a threshold, a decision will be made. The model has separate parameters for the rate of evidence accumulation (i.e., the drift rate), the amount of evidence that is required before a decision is made (i.e., the decision bound), and for non-decision related processing (non-decision time). Interestingly, each of the two strategies discussed above can be linked to one of the parameters in the model. Increasing attention to the color (i.e., the relevant information) will increase the speed with which colors are processed (i.e., the drift rate), but not necessarily change the amount of evidence required to select a response (i.e., the decision bound). Thus, when participants expect most of the trials to be congruent, drift rates should be high when they encounter a congruent trial (i.e., fast accumulation of evidence; an easy trial) and low when they encounter an incongruent trial (i.e., slow accumulation of evidence; a difficult trial). When participants expect most of the trials to be incongruent, the reverse should be true. Importantly, whether participants expect mostly congruent or mostly incongruent trials should leave the decision bound unaffected. The decision bound should, however, be affected by the instructions to balance speed and accuracy. Trading speed for accuracy results in an elevated decision bound, while leaving the drift rate unaffected (Forstmann et al., 2008). Thus, drift-diffusion model analysis of the data might help to shed light on different underlying mechanisms of behaviorally indistinguishable proportion congruency effects.

2. Experiment

1. *Method*

1. *Participants*

Twenty-five participants (four males, mean age: 20.6 years, *SD* = 3.4, range 18–33) took part in the experiment. Participants provided written informed consent before participation, and were awarded course credit. All reported normal or corrected-to-normal vision and were naive with respect to the hypothesis.

2. *Stimuli and apparatus*

The experiment was programmed in *E*-prime for Windows (Psychology Software Tools, Pittsburgh, PA) and run on Intel Pentium 4 computers with 17 in. LCD screens. The refresh rate was set to 60 Hz. Targets were four color patches (3.5° wide and 3.5° high) in blue (RGB 0, 0, 255), yellow (RGB 255, 242, 0), green (RGB 34, 177, 76) or orange (RGB 255, 127, 39), presented on a black background. Responses were executed on Cedrus response boxes (type RB-840).

3. *Procedure*

Participants were instructed to respond with the left index finger to blue and yellow patches and with the right index finger to green and orange patches (reversed for half of the participants). Patches were presented at the left or right side of the screen (at 9.7°). Each trial started with a white fixation cross for 500 ms, followed by the color patch, which was presented until a response was made. The inter-trial interval (ITI) lasted 1000 ms. Each block contained an equal number of congruent and incongruent trials.

The experiment started with sixteen practice trials where feedback was presented during the ITI when participants made an error. Afterwards, each participant performed five blocks of eighty trials, without feedback. The first of these five blocks was a baseline block, where participants were instructed to respond as fast and accurate as possible. Next, four otherwise identical blocks were administered that were preceded by different instructions. In Table 1, a translation of the different instructions can be found. In the speed/accuracy instruction blocks, the instructions stressed either speed (i.e., promoting a liberal response threshold) or accuracy (i.e., promoting a conservative response threshold). In the allocation of attention instruction blocks, the instructions stressed that most of the trials would be congruent or most of the trials would be incongruent, and participants were told to strategically use the irrelevant location information depending on the proportion of congruent trials. The order of the four instructions conditions was fully counterbalanced, with the exception that the liberal and conservative instruction conditions and the mostly congruent and mostly incongruent instruction conditions were always presented in adjacent blocks.

Table 1
Translation of the instructions of the four instruction conditions.

Liberal	In the next block, try to respond as quickly as possible. Don't think too much about your response, and trust your feelings/intuitions strongly when responding to the color of the stimulus. You may make more errors, but that is not a problem. Just make sure to use a very liberal response strategy.
Conservative	In the next block, try to respond as carefully as possible. Make sure to process the color of the square very thoroughly before you give your response. This does not mean that you necessarily have to respond slower, the main thing you have to try is to use a very conservative response strategy.
Mostly Congruent	In the next block, most of the trials will be congruent. This means that the location of the stimulus (left or right) will correspond to the response hand (left or right) on most of the trials. This will not always be the case, but it will be so for the majority of trials. This will be helpful to perform the task, so try to proactively use this information when you perform the task.
Mostly Incongruent	In the next block, most of the trials will be incongruent. This means that the location of the patch (left or right) will NOT correspond to the response hand (left or right) on most of the trials. This will not always be the case, but it will be so for the majority of trials. This will be helpful to perform the task, so try to proactively use this information when you perform the task.

3. Results

1. Reaction times

To examine the influence of instruction condition on performance, a 2 (congruency: congruent or incongruent) by 5 (instruction condition: baseline, liberal, conservative, mostly congruent or mostly incongruent) repeated measures analysis of variance was conducted on the median RTs of correct trials (92.4%). There were main effects of congruency, $F(1,24) = 22.80$, $p < 0.001$, and instruction condition, $F(4,21) = 10.62$, $p < 0.001$, and an interaction between both, $F(4,21) = 2.94$, $p = 0.045$ (see Fig. 1A). Congruency effects were significant in the baseline block: 24 ms, $t(24) = 2.66$, $p = 0.014$, in the liberal instruction condition: 26 ms, $t(24) = 3.31$, $p = 0.002$, in the conservative instruction condition: 24 ms, $t(24) = 1.85$, $p = 0.07$, and in the mostly congruent instruction condition: 42 ms, $t(24) = 3.48$, $p = 0.002$. The congruency effect was non-significantly reversed in the mostly incongruent instruction condition: -12 ms, $t(24) = -1.18$, $p = 0.25$. Congruency effects were not different between the conservative (24 ms) and the liberal instruction condition (26 ms), $|t| < 1$, and both were not different from baseline, both $|ts| < 1$. The congruency effect in the mostly incongruent instruction condition (−12 ms) was smaller than that in the mostly congruent instruction condition (42 ms), $t(24) = 3.34$, $p = 0.003$. Only the mostly incongruent instruction condition differed from baseline, $t(24) = -2.61$, $p = 0.030$, whereas the mostly congruent instruction condition did not, $t(24) = 1.17$, $p = 0.25$. In sum, in RTs only the instruction that most of the trials would be incongruent affected the size of the congruency effect.

2. Error rates

The same analysis as above was also performed on the error rates. There were main effects of congruency, $F(1,24) = 13.28$, $p = 0.001$, and instruction condition, $F(4,21) = 9.21$, $p < 0.001$, and an interaction between both, $F(4,21) = 4.76$, $p = 0.006$ (see Fig. 1B). Congruency effects were significant in the baseline block: 2.0%, $t(24) = 2.49$, $p = 0.020$, in the liberal instruction condition: 8.9%, $t(24) = 4.20$, $p < 0.001$, in the mostly congruent instruction condition: 7.1%, $t(24) = 3.04$, $p = 0.005$, and significantly reversed in the mostly incongruent instruction condition: −3.0%, $t(24) = -1.84$, $p = 0.07$. The congruency effect was not significant in the conservative instruction condition, −0.1%, $t(24) = -0.15$, $p = 0.88$. Congruency effects were significantly smaller in the conservative (−0.1%) than in the liberal instruction condition (8.9%), $t(24) = 3.61$, $p = 0.001$, and both differed from baseline, $t(24) = -1.91$, $p = 0.067$ and $t(24) = 3.66$, $p = 0.001$, respectively. In the mostly incongruent instruction condition (−3.0%), congruency effects were significantly smaller than in the mostly congruent instruction condition (7.1%), $t(24) = 2.97$, $p = 0.006$. Both differed from baseline, $t(24) = -2.61$, $p = 0.015$ and $t(24) = 2.41$, $p = 0.024$, respectively. In sum, contrary to the RTs, in all instruction conditions the congruency effect was different from the baseline condition, in the predicted direction.

3. Diffusion-model analysis

Based on the analyses of RTs and error rates, it becomes clear that the different instructions were effective in inducing a proportion congruency effect. It was next examined whether both types of instructions were effective by means of different underlying mechanisms. For this purpose, the data were fitted using the drift-diffusion model. Because there are a limited number of error trials in the current dataset, the robust-EZ diffusion model was used (Wagenmakers, van der Maas, Dolan, & Grasman, 2008). This algorithm only uses the proportion of errors and the mean and variance (extracted from an ex-

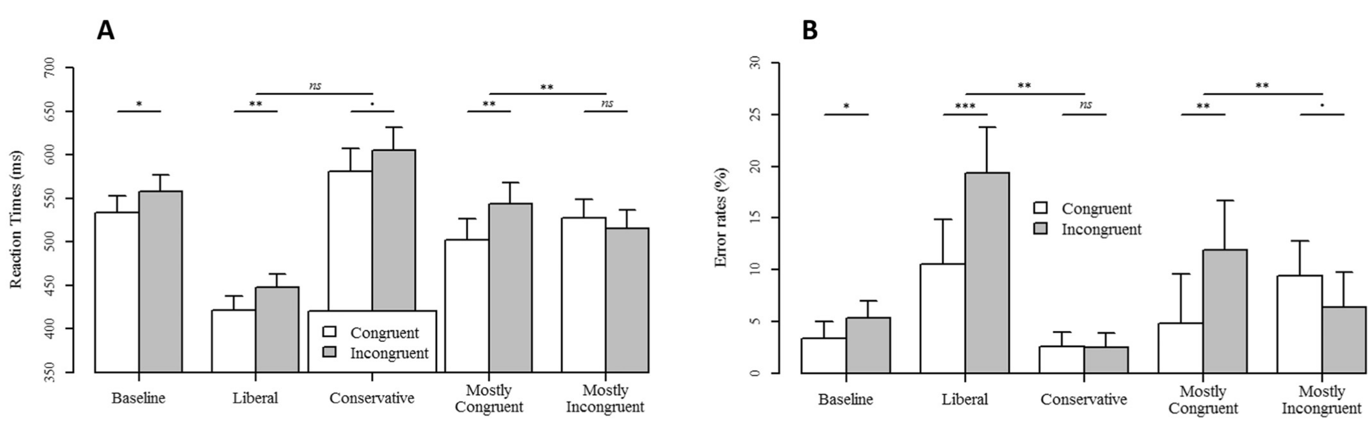

Fig. 1. Behavioral results, separately for reaction times (A) and error rates (B). In terms of visual input, each block was identical, the only thing different being the instructions given.Note that the horizontal lines reflect main effects of congruency (lowest) and interactions between congruency and instruction condition (highest). Error bars reflect 95% within-subjects confidence intervals.Note: *ns* non-significant;. $p < 0.1$, * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

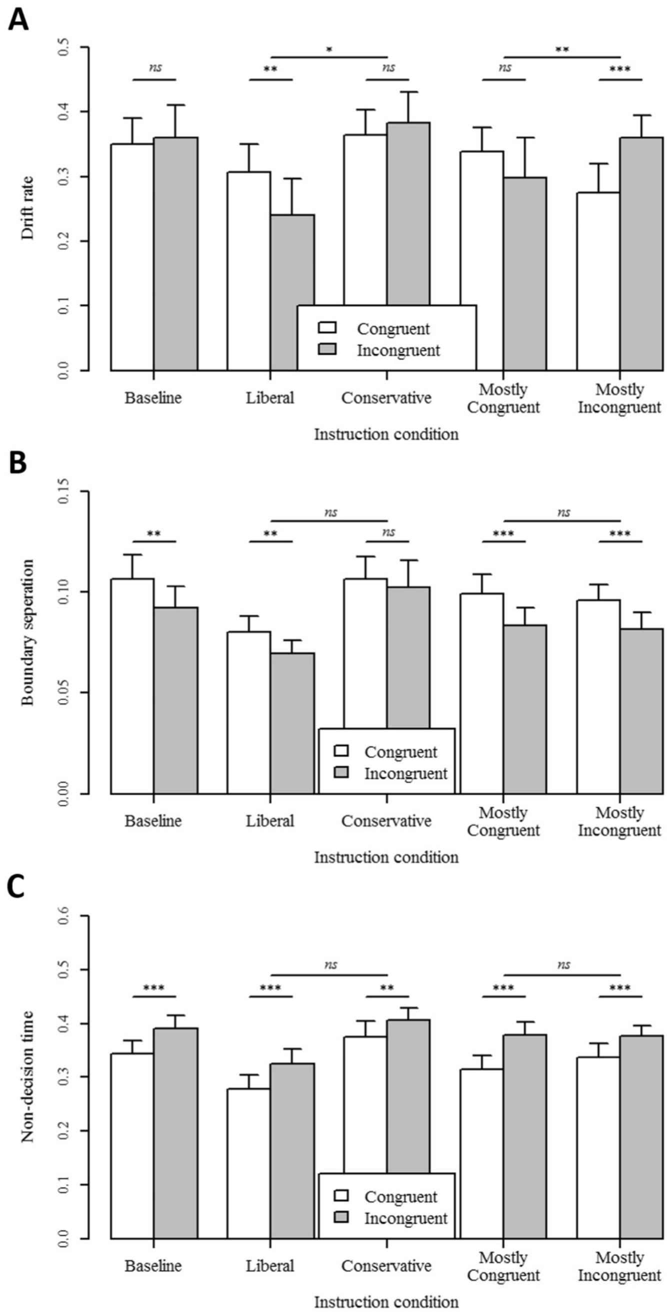

Fig. 2. Model output, separately for drift rate (A) decision bound (B) and non-decision time (C).Note that the horizontal lines reflect main effects of congruency (lowest) and interactions between congruency and instruction condition (highest). Error bars reflect 95% within-subjects confidence intervals.Note: *ns* non-significant; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Gaussian fit to the data) to fit the drift-diffusion model. When the proportion of errors in a condition was zero, the standard edge-correction proposed in Wagenmakers, van der Maas, and Grasman (2007) was used. This was, on average, the case for 2.24 of the ten conditions ($SD = 1.90$, range 0–7). When the distribution of a condition had a negative skew, the skew value was replaced with zero. This was, on average, the case for 0.48 of the ten conditions ($SD = 0.74$, range 0–2). The same repeated measures ANOVA as reported above was performed on the drift rates, decision bounds, and non-decision times. The results can be found in Fig. 2.

The drift rate was modulated by instruction condition, $F(4,21) = 4.77$, $p = 0.007$, not by congruency, $F < 1$, but there was a significant two-way interaction, $F(4,21) = 9.64$, $p < 0.001$. Most critically, as predicted the effect of congruency on the drift rate was different between the mostly congruent and the mostly incongruent instruction condition, $t(24) = 3.64$, $p = 0.001$. The congruency effect in the drift rate was (non-significantly) positive in the mostly congruent instruction condition ($M = 0.04$), $t(24) = 1.65$, $p = 0.11$, whereas it was significantly reversed in the mostly incongruent instruction condition ($M = -0.08$), $t(24) = -4.79$, $p < 0.001$. Thus, when participants expected mostly incongruent trials, the rate of evidence accumulation for incongruent trials was also higher than that for congruent trials. This finding is consistent with the hypothesis that participants allocated attention to the color depending on the expected number of congruent trials. Unexpectedly, there was also a significant interaction between the liberal and the conservative instruction condition, $t(24) = 2.77$, $p = 0.010$, with a positive congruency effect in the liberal instruction condition ($M = 0.06$), $t(24) = 2.81$, $p = 0.009$, whereas there was no difference between congruent and incongruent trials in the conservative instruction condition ($M = -0.02$), $t(24) = -1.15$, $p = 0.26$. Although the modulation of congruency by instruction condition was numerically larger in the mostly congruent/incongruent compared to the liberal/conservative instruction conditions, this difference was not significant, $|t| < 1$. Finally, mean drift rate was not different between the mostly congruent ($M = 0.32$) and the mostly incongruent instruction condition ($M = 0.32$), $|t| < 1$. There was, however, a difference between the liberal ($M = 0.27$) and the conservative instruction condition ($M = 0.37$), $t(24) = -4.46$, $p < 0.001$. Mean drift rate in the baseline ($M = 0.35$) only differed from the liberal instruction condition, $t(24) = 3.39$, $p = 0.002$, but not from the other conditions, $ps > 0.075$.

The decision boundary was modulated by congruency, $F(1,24) = 52.49$, $p < 0.001$, and by block, $F(4,21) = 12.51$, $p < 0.001$, but there was not interaction between both, $F < 1$. Crucially, as predicted, the decision bound was, on average, lower in the liberal instruction condition ($M = 0.07$) than in the conservative instruction condition ($M = 0.10$), $t(24) = 5.16$, $p < 0.001$. Importantly, the bound was not different between the mostly congruent ($M = 0.09$) and the mostly incongruent ($M = 0.09$) instruction condition, $|t| < 1$. A paired *t*-test confirmed that the effect on decision bound was different between both instruction conditions, $t(24) = 4.44$, $p < 0.001$. This finding is compatible with the hypothesis that in the speed/accuracy instruction conditions the underlying mechanism affecting the size of the congruency effect is a change in decision bound. Finally, the bound differed for congruent and incongruent trials in the baseline block, $t(24) = 3.37$, $p = 0.002$, in the liberal, $t(24) = 3.00$, $p = 0.006$, the mostly congruent, $t(24) = 3.93$, $p < 0.001$, and the mostly incongruent instruction conditions, $t(24) = 4.28$, $p < 0.001$, whereas there was no difference in the conservative instruction condition, $|t| < 1$.

The non-decision time was modulated by congruency, $F(1,24) = 110.94$, $p < 0.001$, and by block, $F(4,21) = 5.92$, $p = 0.002$, but there was no interaction, $F(4,21) = 1.26$, $p = 0.31$. Non-decision time differed for congruent and incongruent trials in the baseline block, $t(24) = 3.76$, $p < 0.001$, in the liberal, $t(24) = 4.89$, $p < 0.001$, the conservative, $t(24) = 3.50$, $p = 0.001$, the mostly congruent, $t(24) = 5.03$, $p < 0.001$, and the mostly incongruent instruction conditions, $t(24) = 4.54$, $p < 0.001$. The effect of congruency on the non-decision time did not differ between the liberal and the conservative, $p = 0.27$, and between the mostly congruent and the mostly incongruent instruction conditions, $p = 0.12$. Finally, non-decision time was, on average, larger in the conservative than in the liberal instruction condition, $t(24) = 4.83$, $p < 0.001$, whereas the mostly congruent and the mostly incongruent instruction conditions did not differ, $p = 0.29$.

In sum, as predicted the instructions that most of the trials would be congruent versus incongruent affected the drift rate. When participants expected most of the trials to be incongruent, drift rates were higher for incongruent trials than for congruent trials, whereas the reverse was true when they expected mostly congruent trials. On the other hand, instructions to balance speed and accuracy modulated the decision bound, although these instructions did not selectively affect the bound but also drift rate and non-decision time. Jointly, these results suggest that both instruction conditions affected the congruency effect by means of different underlying mechanisms.

4. Awareness

After finishing the mostly congruent and mostly incongruent instruction blocks, participants were asked whether they had counted the proportion of congruent trials, and whether they had been aware of the fact that the proportion congruency was not manipulated. Only one participant out of twenty-five indicated that they counted the number of congruent versus incongruent trials. Most of the participants (20 out of 25, $\times^2(1, N = 25) = 9, p = 0.003$) did, however, note that the ratio of congruent and incongruent trials was actually identical in both blocks.

4. Discussion

In the current work, the effectiveness of different instructions in inducing a proportion congruency effect was examined. Prior to the start of each block, participants were instructed to strategically use the (false) information that most of the trials would be congruent/incongruent, or they were told to focus on speed/accuracy. A notable advantage of this method is that the actual proportion of congruent trials can be held constant, thereby ruling out prominent stimulus-based confounds. The congruency effect differed from baseline in all four instruction conditions in the predicted direction, however, only in the error rates this was statistically significant for all comparisons. For RTs, only the instruction that most of the trials would be incongruent significantly affected the size of the congruency effect. A diffusion-model analysis of the data was partially consistent with the hypothesis that the instructions induced a proportion congruency effect by means of different underlying mechanisms.

1. Two strategies to verbally induce a proportion congruency effect

An important aim of the current work was to examine whether different instructions can be used to induce a proportion congruency effect. In previous work, participants were (falsely) informed that the number of congruent trials would be large or small (Bugg & Smallwood, 2016; Bugg et al., 2015; Entel et al., 2014). However, because participants in earlier studies were not instructed *how* they needed to use this information, it is unclear which mechanisms underlie these verbally induced proportion congruency effects. One option is that participants strategically allocate attention depending on the number of congruent trials. Alternatively, however, participants might have expected that the difficulty of the task depends on the number of congruent trials, and therefore changed their response caution depending on the expected task difficulty. In the current work, the instructions explicitly told participants which specific strategy they needed to use to perform the task. It was observed that these different strategies can lead to similar behavioral outcomes.

To formally examine whether the different instruction conditions were effective by means of different underlying mechanisms, the data were fit to a drift-diffusion model. It was predicted that the instructions to strategically allocate attention or to change the trade-off between speed and accuracy would map onto different parameters of the model. Indeed, the estimated drift rate was higher for congruent than for incongruent trials when participants expected mostly congruent trials, whereas the reverse was true when they expected mostly incongruent trials. Thus, when participants expected mostly incongruent trials, the rate of evidence accumulation was higher for incongruent than for congruent trials. This is in line with the hypothesis that these instructions induce a strategic allocation of attention. Importantly, the decision bound did not differ between both instruction conditions. As expected, instructions concerning speed/accuracy modulated the height of the decision bound (see also Forstmann et al., 2008; King, Korb, & Egner, 2012). The influence of these instructions was, however, not restricted to the decision bound. Mean drift rate and the non-decision time were also higher in the conservative compared to the liberal instruction condition. Taken together, the results of this model-based analysis are in line with the hypothesis that both types of instructions are effective by means of different underlying mechanisms. A final important caveat is that the model attributed the effect of congruency to the non-decision time and (inversely) to the decision bound. This is unexpected, given that from a theoretical point of view the effect of congruency should be reflected in the drift rate (Abrahamse, Braem, Notebaert, & Verguts, 2016). One reason for this might be that the processing of conflict violates the assumption of the diffusion model of a constant drift rate. The effect of conflict on RTs depends on the speed of responding (Pratte, Rouder, Morey, & Feng, 2010; Ridderinkhof, Wildenberg, Wijnen, & Burle, 2004), and therefore more complex models might be needed to capture the effect of conflict within the drift-diffusion framework (Schwarz & Miller, 2012).

In sum, the results of a drift-diffusion model fit were partially consistent with the hypothesis that the instructions to strategically allocate attention and the instructions to balance between speed and accuracy, induce a proportion congruency effect by means of different underlying mechanisms.

2. Reversed congruency effects

Apart from the results of the drift-diffusion model, there was also some evidence in the error data that allocation of attention and trading speed for accuracy are dissociable strategies. A negative congruency effect was observed in the mostly incongruent instruction condition. Although this effect just failed to reach significance, this was likely because most of the participants became aware over the course of the block that there was in fact no proportion congruency manipulation. Indeed, in the first half of the mostly incongruent instruction block (i.e., when participants were still unsure about the validity of the instructions), this reversed congruency effect was significant, -5.1%, $t(25) = -1.18$, $p = 0.039$.[1] In two-choice tasks, such a reversal of the congruency effect is typically interpreted in terms of strategic control (Merikle & Joordens, 1997; Ortells, Daza, & Fox, 2003): if the irrelevant location information mostly triggers the wrong response, it can be actively used to predict and prepare the opposite (mostly correct) response. Note that such a reversal of the congruency effect cannot be explained by a process of conflict adaptation which predicts that the influence of the irrelevant location information is reduced with an increasing amount of conflict, thus maximally predicting the absence of a congruency effect, not a reversal. Original accounts of reversed congruency effects are framed in terms of contingencies (i.e., predicting the contingent response). As such, the current finding is consistent with a (verbally installed) contingency learning account. Finally, in the error

[1] To formally examine this, the data were reanalyzed with an additional factor coding whether the data belonged to the first vs. second half of a block. The previously reported effects of congruency (RTs: $p < 0.001$, errors: $p = 0.001$), block (RTs: $p < 0.001$, errors: $p < 0.001$) and congruency by block (RTs: $p = 0.042$, errors: $p = 0.010$) remained unchanged. For RTs neither term containing the factor block half was close to significance, all $ps > 0.19$. For error rates there was a close to significant three-way interaction, $F(4,21) = 2.77$, $p = 0.054$. Congruency effects only differed between the first and the second half of a block in the mostly congruent instruction condition, $t(24) = 2.10$, $p = 0.045$, and in the mostly incongruent instruction condition, $t(24) = -2.27$, $p = 0.032$. More specifically, the instruction induced proportion congruency effect was more pronounced in the first half of each block (mostly congruent instruction condition: $M_{incongruent\text{-}congruent} = 9.6\%$, $t(24) = 3.70$, $p = 0.001$; mostly incongruent instruction condition: $M_{incongruent\text{-}congruent} = -5.11\%$, $t(24) = -2.18$, $p = 0.039$) compared to the second half (mostly congruent instruction condition: $M_{incongruent\text{-}congruent} = 4.9\%$, $t(24) = 1.90$, $p = 0.070$; mostly incongruent instruction condition: $M_{incongruent\text{-}congruent} = -0.81$, $t(24) = -0.60$, $p = 0.56$).

rates of the conservative instruction condition the congruency effect was not reversed, rather it simply dropped to zero. This was predicted, given that a change in response threshold can result in the absence of a congruency effect with a very high response threshold, but it cannot lead to a reversal.

3. Implications for theories of cognitive control

Although it might be tempting to relate the allocation of attention instruction conditions to the process of conflict adaptation (because both imply the modulation of attention), the current findings are not necessarily informative with respect to dominant accounts of conflict adaptation, such as the conflict monitoring theory (Botvinick et al., 2001). In this theory, a conflict monitor needs to detect conflict in order for control to be increased. However, one of the key points of the current work was that the degree of conflict was identical in all instruction conditions, thus conflict monitoring theory cannot account for instruction induced proportion congruency effects. The same caution should be taken when linking the speed/accuracy instruction conditions to recent theoretical work arguing that changes in response deadline can account for the proportion congruency effect (e.g., Kinoshita, Mozer, & Forster, 2011; Schmidt, 2013a). In Schmidt (2013a), the proportion congruency effect was explained by assuming that participants learn *when* to respond in a conflict task. Contexts high in conflict are generally error-prone, making it appropriate to adopt a conservative response criterion. Contexts low in conflict are generally easy, thus ideally one would adopt a liberal response criterion here, giving a response with only a minimum of accumulated evidence. Previous work has indeed documented how focusing on speed at the expense of accuracy leads to faster responses based on preliminary information (Band, Ridderinkhof, & van der Molen, 2003; Osman et al., 2000). Thus, differences in speed-accuracy can explain the proportion congruency effect, without assuming a process of conflict adaptation. Although it seems intuitive to map the speed/accuracy instruction conditions onto these response threshold accounts, caution should be taken because these accounts predict a change in response threshold when actually performing a difficult task, whereas in the current study it was examined how participants change their response threshold based on the *expected* difficulty of the task.

Finally, the current study ruled out contingency learning (Schmidt & Besner, 2008), by keeping the proportion of congruent trials constant in all conditions. This does not imply, however, that contingencies did not play any role at all. It has been shown that instructions might serve as a replacement for experience to install a certain S-R link (Liefooghe, Wenke, & De Houwer, 2012; Mertens, Raes, & De Houwer, 2016). As such, as an alternative to the current interpretation that the mostly congruent/incongruent instructions led participants to strategically allocate attention, it could be that these instructions installed S-R links which then affected the congruency effect (e.g., Schmidt & De Houwer, 2012). As already discussed, the reversal of the congruency effect in the mostly incongruent instruction condition is in line with this possibility. Moreover, it should also be noted that the increased evidence accrual for incongruent trials in the mostly incongruent instruction condition is also consistent with a contingency learning account: evidence will accrue more quickly with a contingency present (Schmidt, 2013b).

5. Conclusion

In the current study, verbal instructions effectively induced a proportion congruency effect. Both instructions to strategically allocate attention and instructions influencing the trade-off between speed and accuracy led to similar behavioral outcomes, but a drift-diffusion model analysis of the data was partially consistent with the hypothesis of different underlying mechanisms for both. Importantly, these effects were observed in a list with an equal proportion of congruent and incongruent trials, ruling out contingency confounds.

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