Canadian Journal of Experimental Psychology
2011, Vol. 65, No. 2, 98–104

1196-1961/11/$12.00 DOI: 10.1037/a0021145

# Congruency Proportion Reveals Asymmetric Processing of Irrelevant Physical and Numerical Dimensions in the Size Congruity Paradigm

Karl Borgmann and Jonathan Fugelsang
University of Waterloo

Daniel Ansari
University of Western Ontario

Derek Besner
University of Waterloo

When the proportion of congruent trials in conflict tasks is manipulated (e.g., Stroop, Simon), the typical result is that the magnitude of the conflict effect increases as the proportion of congruent trials increases. The present experiment investigated the influence of Congruency Proportion in the context of the Size Congruity Paradigm. Congruency Proportion had a significant impact on the Numerical Judgement Task (judging which of two numbers is numerically larger), but not on the Physical Judgement Task (judging which of two numbers is printed in a larger font). These data support the inference that physical size information is processed before, and more fluently than, numerical size information. The implications of this asymmetry are discussed in terms of the relative role of semantic and physical size information in representations of magnitude, and the role they play in both of these tasks.

*Keywords:* numerical distance, size congruity, congruency proportion, cognitive control

When the proportion of congruent/compatible trials is manipulated in several cognitive paradigms, the magnitude of the obtained effect typically changes. For example, in the Stroop task, as the proportion of congruent trials increases, the size of the Stroop effect also increases (e.g., Bugg, Jacoby, & Toth, 2008; Logan & Zbrodoff, 1979; Lowe & Mitterer, 1982). This is commonly taken as evidence that both automatic and strategic components are involved in producing the Stroop effect, and is hypothesised to result from the strategic or controlled use of the colour word as a function of its utility in predicting the colour (but see Risko, Blais, Stolz, & Besner, 2008; Schmidt & Besner, 2008). Put another way, both the process of word reading and the process of colour naming are subject to strategic influences that weight the output of said processes as a function of their utility.

Similarly, the proportion of compatible trials influences both the magnitude and direction of the Simon effect. Here, when the compatibility proportion is high, the Simon effect is large, and when the compatibility proportion is low, the Simon effect reverses in direction (e.g., Borgmann, Risko, Stolz, & Besner, 2007). The reversal of direction of the effect likely reflects the fact that this task typically involves two choices in which there are only two levels for each dimension. Thus, in the two choice task, when the proportion of compatible trials is low, location is predictive of the *opposite* response key. Two choice (two colour) Stroop tasks can also produce a reversal in the Stroop effect when there are more incongruent trials than congruent ones (Merikle & Joordens, 1997). Again, this suggests that strategic components are contributing to the magnitude of the obtained effect.

It has been suggested that the Congruency Proportion effect is due to the modulation of controlled processing (Botvinick, Braver, Barch, Carter, & Cohen, 2001). Specifically, as the proportion of congruent trials increases, the amount of control is reduced. Put another way, when there are more congruent than incongruent trials in the context of the Stroop paradigm, the more fluent process of word reading is more heavily weighted than colour naming, because most of the time reading the word will generate the correct response. This leads to a pattern of data in which response times and errors to incongruent trials increase as congruency proportion increases because the subject must "recover" from attempting to respond on the basis of the word given that it is incorrect.

In the present experiment, we investigated the influence of Congruency Proportion on the Size Congruity effect. The Size Congruity effect refers to the impact that congruency between the physical (i.e., font size of Arabic numerals) and semantic (i.e., numerical magnitude) dimensions of a numerical stimulus has on the time it takes to make a judgement about that stimulus. In numerous experiments with both adults and children it has been shown that the physical size of an Arabic numeral or number word affects the processing of relative magnitude (e.g., Ansari, Fugelsang, Dhital, & Venkatraman, 2006; Besner & Coltheart, 1979; Girelli, Lucangeli, & Butterworth, 2000; Henik & Tzelgov, 1982; Rubinsten, Henik, Berger, & Shahar-Shalev, 2002; Schwarz & Ischebeck, 2003; Tzelgov, Meyer, & Henik, 1992). Typically, subjects are asked to identify which of two numbers is *numerically*

Karl Borgmann, Jonathan Fugelsang, and Derek Besner, Department of Psychology, University of Waterloo; Daniel Ansari; Department of Psychology, University of Western Ontario.

This research was supported by Discovery Grants from the Natural Sciences and Engineering Research Council of Canada (NSERC) awarded to Jonathan Fugelsang, Daniel Ansari, and Derek Besner.

Correspondence concerning this article should be addressed to Jonathan Fugelsang, Department of Psychology, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, Canada, N2L 3G1. E-mail: jafugels@uwaterloo.ca

larger, and to ignore the physical size in which the numbers are presented. The standard finding is that subjects are faster when the numerically larger numeral also appears in a larger font size (congruent trial) than when the numeral printed in the larger font size is numerically smaller (incongruent trial). Thus, there is significant interference on the judgement of *relative* numerical magnitude from the *irrelevant* physical size. Conversely, it has also been found that when subjects are asked to judge which of two stimuli is *physically* larger, there is interference from the *irrelevant* numerical magnitude. This impact of irrelative numerical information on physical judgements is typically smaller than the impact of irrelevant physical information on numerical judgements (e.g., Henik & Tzelgov, 1982).

The degree to which judgements of both dimensions are susceptible to manipulations that impact the influence of strategic processing within the same task, however, has not been systematically assessed, and is the focus of the current investigation. Given that Congruency Proportion is thought to index strategic control (Botvinick et al., 2001), this manipulation offers a powerful method by which to test the relative strength of the interference effects in both directions, and subsequently the degree to which such control influences responding to that dimension (i.e., physical vs. numerical) of the stimuli. Against the background of evidence for a stronger influence of physical size on judgements of numerical magnitude relative to numerical magnitude on judgements of physical size (arguably, because of the relative fluency of these two components), we expect that a Congruency Proportion manipulation will have a larger influence in the Numerical Judgement task than the Physical Judgement task. More specifically, we expect that the Congruency by Congruency Proportion interaction will be larger in the Numerical Judgement task than in the Physical Judgement task (i.e., a three way interaction between Congruency, Congruency Proportion, and Task). This will provide key evidence regarding the degree to which each dimension can be influenced by strategic control.

One long standing problem with comparisons across tasks, is that physical judgements are typically faster than numerical judgements. As such, if a larger effect of the irrelevant physical dimension was found on numerical judgements (and subsequently larger effects of Congruency Proportion), this finding may be driven entirely or in part by the slower absolute reaction times (RTs) in the numerical task, rather than the speed or fluency to which semantics versus physical magnitude information is activated in that task (Pansky & Algom, 1999). That is, the very asymmetry in mean RTs between physical and numerical judgements may produce the asymmetry in the influence of the Congruency and Congruency Proportion manipulation because of a scaling effect. In the following experiment, we strived to equate the Physical and Numerical Judgement tasks on RT (and errors) by increasing the difficulty of the Physical Judgement task to make baseline responding to these two dimensions roughly equivalent.[1] By statistically equating baseline responding in these two tasks, we can be confident that it is the speed by which the relevant information (i.e., physical size vs. numerical magnitude information) becomes activated and is available for processing, rather than the baseline speed of the judgement tasks, that determines the degree to which judgements of both dimensions are susceptible to strategic processing.

# Method

## Participants

Sixty-nine undergraduate students with normal or corrected-to-normal vision from the University of Waterloo participated for course credit.

## Design

Each task (Numerical and Physical Judgement) contained stimuli that varied in terms of Congruency (Congruent vs. Incongruent), Symbolic Distance (1, 3, and 5) and Congruency Proportion (.25 vs. .75 congruent). Stimuli consisted of the numerical digits 1 through 9 inclusive, presented in Arial font sizes 44 (1.47° of visual angle), 54 (1.88° of visual angle), and 64 (2.21° of visual angle) with each symbolic distance being presented equally in every possible combination of congruency, font size, and side (left or right of fixation). Congruency Proportion was manipulated by presenting proportionately less or more (.25 or .75) congruent trials from the stimulus set while maintaining an equal number of trials at each of the three distances for both judgement tasks (a complete list of stimuli is available upon request). Therefore, trial composition was identical for the Numerical and Physical Judgement task.

Congruency and Symbolic Distance were within-subject variables, and Congruency Proportion and Judgement task were between-subjects variables. For the Numerical Judgement task, 17 participants took part in the .25 Congruency Proportion condition and 17 participants in the .75 Congruency Proportion condition. For the Physical Judgement task, 16 participants took part in the .25 Congruency Proportion condition, and 19 participants in the .75 Congruency Proportion condition. Trials were considered *congruent* when the target stimulus was both numerically and physically larger (e.g., 7 and 2), and *incongruent* when the target stimulus was numerically larger but physically smaller (e.g., 7 and 2).

## Procedure

The stimuli were presented on a 17″ colour monitor driven by a Pentium computer running E-Prime v1.1 software (Psychological Software Tools, Pittsburgh, PA). The targets consisted of two numerals presented to the left and right of a central fixation point (+). The physically large numeral was presented in font size 64 or 54 and the physically small numeral was presented in font size 54 or 44. Responses were collected using a standard QWERTY keyboard. Participants were told to identify which of the two numbers was larger (Physically or Numerically depending on the task) by pressing the “Q” key to denote the number on the left was larger,

[1] Baseline physical and numerical judgments were virtually identical in RTs despite a main effect of Task. That is, because of the differential interactions of Task with Congruency, Congruency Proportion, and Symbolic Distance, a main effect of Task is to be expected as the differences in slopes increase the marginal Task means. If we directly compare the congruent conditions at the distance of 5 (arguably the best approximation of a baseline for this experiment), performance on the two tasks are not significantly different (mean difference = 17 ms), $t(67) < 1$. In addition, there was no main effect of Task on errors ($F < 1$).

and the "P" key to denote the number on the right was larger. The midpoint between the two response keys was aligned with the central fixation. Participants were tested individually in a sound attenuated room. Instructions for the task were displayed visually and relayed verbally by the experimenter. Participants were instructed to respond as quickly and accurately as possible.

Each trial began with the presentation of a fixation point for 900 ms. Subsequently, the target numerals were presented and remained on the screen until a response was made. Twelve practise trials with a Congruency Proportion of .50 were followed by 576 experimental trials (192 trials per Symbolic Distance). Trial order was determined randomly for each subject.

## Results

### RTs

RT analyses were conducted for all trials in which the response was correct. RTs were submitted to a recursive data trimming procedure (Van Selst & Jolicoeur, 1994) using a 2.5 *SD* cut-off in each cell resulting in 3.8% of the RT data being removed. The alpha level for all statistical tests was set at .05 (two-tailed) unless otherwise stated. Effect size estimates were computed using partial $\eta^2$.

A 2 (Congruency: Congruent vs. Incongruent) × 3 (Symbolic Distance: 1, 3, and 5) × 2 (Congruency Proportion: .25 vs. .75) × 2 (Task: Numerical vs. Physical) mixed ANOVA was conducted on mean RTs (see Figure 1), revealing a significant four-way interaction, $F(2, 130) = 6.32$, $MSE = 436$, $\eta^2 = .09$. This four-way interaction is the product of a Congruency × Symbolic Distance × Congruency Proportion interaction for the Numerical Judgement task, $F(2, 64) = 5.43$, $MSE = 400$, $\eta^2 = .15$, but not the Physical Judgement task, $F(2, 66) = 1.72$, $MSE = 472$, $\eta^2 = .05$. In the Numerical Judgement task, there was a Congruency × Congruency Proportion interaction for all Symbolic Distances (smallest $F = 19.10$). However, the magnitude of the interaction (in terms of the Congruency × Congruency Proportion difference of differences) was largest for the Symbolic Distance of 1 (mean difference of differences = 81.59) compared to the Symbolic Distance of 3 (mean difference of differences = 48.00) and 5 (mean difference of differences = 38.59). These comparisons were substantiated with Fishers Protected *t* tests (using the *MSE* and *df* from the three-way interaction), which confirmed that each of the Congruency × Congruency Proportion interactions for the three symbolic distances were significantly different from each other (smallest $t(64) = 2.70$, $p < .05$). For the Physical Judgement task, however, there was no Congruency × Congruency Proportion interaction at any Symbolic Distance (largest $F = 1.7$ for Symbolic Distance 5). We now focus our data analyses on two key aspects of our data that directly speak to our predictions: (1) interactions between Congruency, Congruency Proportion and Task, and (2) interactions with Symbolic Distance.

**Congruency, Congruency Proportion, and Task.** Most important given our predictions, there was a three-way interaction between Congruency, Congruency Proportion, and Task, $F(1, 65) = 4.85$, $MSE = 2{,}628$, $\eta^2 = .07$. As is evident in Figure 1, the Congruency Proportion manipulation had a significant impact on the Congruency effect for the Numerical Judgement task, $F(1, 32) = 28.88$, $MSE = 463$, $\eta^2 = .47$, but not the Physical Judgement Task ($F < 1$). Specifically, the size congruency effect (in-

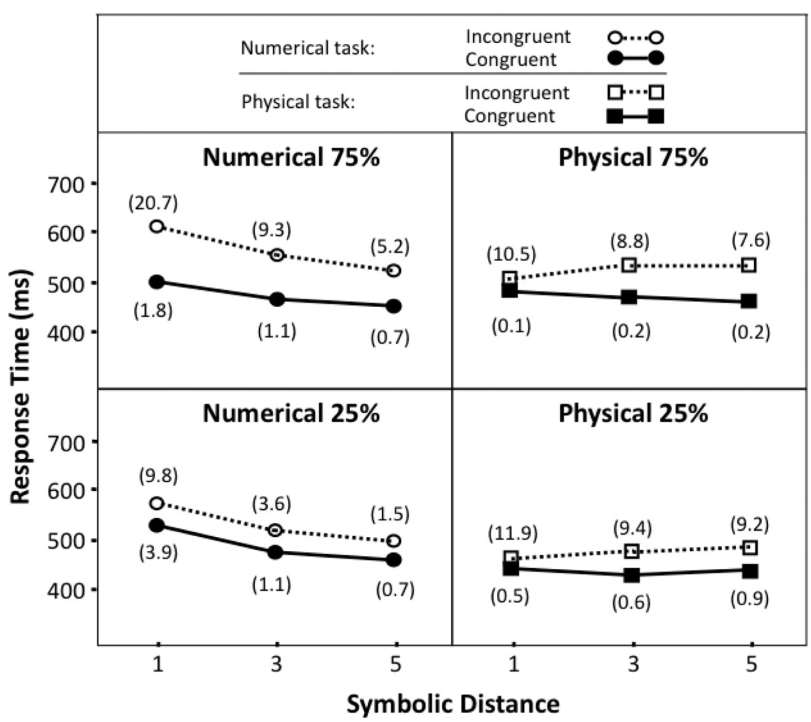


*Figure 1.* Mean RTs (milliseconds) and percentage errors (in brackets) as a function of Judgement Task, Congruency Proportion, Congruency, and Symbolic Distance.

congruent—congruent) for the Numerical Judgement task increased from 35 ms in the .25 Congruency Proportion condition, to 91 ms in the .75 Congruency Proportion condition, whereas for the Physical Judgement task the congruency effect remained statistically equivalent (37 ms in the .25 Congruency Proportion condition, and 49 ms in the .75 Congruency Proportion condition).

Consistent with prior research, Congruency and Task also interacted, $F(1, 65) = 4.0$, $MSE = 2{,}628$, $\eta^2 = .06$, $p = .05$, in that the difference between congruent and incongruent trials was larger for the Numerical Judgement task (mean difference = 63 ms) than the Physical Judgement task (mean difference = 43 ms). In addition, the expected two-way interaction between Congruency and Congruency Proportion was also significant, $F(1, 65) = 11.23$, $MSE = 2{,}628$, $\eta^2 = .15$, such that as the proportion of congruent trials increased, so too did the difference in RTs for congruent and incongruent trials.

**Interactions with Symbolic Distance.** With respect to interactions with Symbolic Distance, there was a three-way interaction between Symbolic Distance, Congruency and Task, $F(2, 130) = 20.0$, $MSE = 436$, $\eta^2 = .24$. This three-way interaction was the product of two Symbolic Distance by Congruency interactions that take opposite forms. Specifically, for the Numerical Judgement task, as Symbolic Distance *increased*, the size of the congruency effect got *smaller*, $F(2, 64) = 6.50$, $MSE = 400$, $\eta^2 = .17$, whereas for the Physical Judgement task, as the Symbolic Distance *increased*, the size of the congruency effect got *larger*, $F(2, 66) = 14.22$, $MSE = 471$, $\eta^2 = .30$.

There was also a two-way interaction between Symbolic Distance and Task, $F(2, 130) = 89.40$, $MSE = 654$, $\eta^2 = .58$, as well as main effects of Congruency, $F(1, 65) = 109.37$, $MSE = 2{,}628$, $\eta^2 = .63$, Symbolic Distance, $F(2, 130) = 70.10$, $MSE = 654.10$, $\eta^2 = .52$, and Task, $F(1, 65) = 6.54$, $MSE = 36{,}825$, $\eta^2 = .09$. These findings are qualified by the higher order interactions presented above, however, and are thus not further discussed. No other main effects or interactions were significant (largest $F = 1.28$).

## Errors

A parallel 2 (Congruency: Congruent vs. Incongruent) × 3 (Symbolic Distance: 1, 3, and 5) × 2 (Congruency Proportion: .25 vs. .75) × 2 (Task: Numerical vs. Physical) mixed ANOVA on errors revealed a significant four-way interaction, $F(2, 130) = 6.67$, $MSE = .001$, $\eta^2 = .09$. As was the case in the RT analyses, this four-way interaction is the product of a significant Congruency × Symbolic Distance × Congruency Proportion interaction for the Numerical Judgement task, $F(2, 64) = 11.73$, $MSE = 0.001$, $\eta^2 = .27$, but not the Physical Judgement task, $F < 1$. In the Numerical Judgement task, there was a Congruency × Congruency Proportion interaction for all Symbolic Distances (smallest $F = 9.14$). However, the magnitude of the interaction (in terms of the Congruency × Congruency Proportion difference of differences) was largest for the Symbolic Distance of 1 (mean difference of differences = .13) compared to the Symbolic Distance of 3 (mean difference of differences = .05) and 5 (mean difference of differences = .04). These comparisons were substantiated with Fishers Protected *t* tests (using the *MSE* and *df* from the three-way interaction), which confirmed that the Congruency × Congruency Proportion interaction for the Symbolic Distance of 1 was significantly larger than the effect at the Symbolic Distances of 3, $t(64) = 14.55$, $p < .05$ and 5, $t(64) = 16.36$, $p < .05$. The Congruency × Congruency Proportion interactions for the Symbolic Distances of 3 and 5 were not significantly different from each other, $t(64) = 1.82$, $p > .05$. Importantly, mirroring the RT analyses, there was no Congruency × Congruency Proportion interaction at any Symbolic Distance for the Physical Judgement task (all $F$s $< 1$). We now decompose the error data analyses in a parallel fashion to the RT analyses.

**Congruency, Congruency Proportion, and Task.** As with the RT analyses, and central to our predictions, there was a three-way interaction between Congruency, Congruency Proportion and Task, $F(1, 65) = 14.84$, $MSE = .003$, $\eta^2 = .19$. This interaction was of identical form to the RTs. Specifically, the Congruency Proportion manipulation had a significant impact on the Congruency effect for the Numerical Judgement task, $F(1, 32) = 16.10$, $MSE = .004$, $\eta^2 = .34$, but not the Physical Judgement Task ($F < 1$).

Congruency and Task also interacted, $F(1, 65) = 5.11$, $MSE = .003$, $\eta^2 = .07$. Here, however, the difference between congruent and incongruent trials was slightly larger for the Physical Judgement task (mean difference = 9.2%) than the Numerical Judgement task (mean difference = 7.0%). In addition, the expected two-way interaction between Congruency and Congruency Proportion was also significant, $F(1, 65) = 10.434$, $MSE = .003$, $\eta^2 = .14$, such that as the proportion of congruent trials increased, so too did the difference between errors for congruent and incongruent trials.

**Interactions with Symbolic Distance.** With respect to interactions with Symbolic Distance, there was a three-way interaction between Symbolic Distance, Congruency, and Task, $F(2, 130) = 12.40$, $MSE = .001$, $\eta^2 = .16$. This three-way interaction was the product of two Symbolic Distance by Congruency interactions that were of different magnitudes. Specifically, consistent with the RT analyses, for the Numerical Judgement task, as Symbolic Distance *increased*, the size of the congruency effect got *smaller*, $F(2, 64) = 49.39$, $MSE = .001$, $\eta^2 = .61$. Unlike the RT analyses, however, for the Physical Judgement task, as Symbolic Distance *increased*, the size of the congruency effect also got *smaller*, $F(2, 66) = 5.20$, $MSE = .001$, $\eta^2 = .14$, just to a significantly less degree. There was also a three-way interaction between Symbolic Distance, Congruency and Congruency Proportion, $F(2, 130) = 5.75$, $MSE = .001$, $\eta^2 = .08$. Here, the Symbolic Distance by Congruency interaction was moderately smaller in the .25 Congruency Proportion condition than the .75 Congruency Proportion condition.

There were also two-way interactions between Symbolic Distance and Task, $F(2, 130) = 30.52$, $MSE = .001$, $\eta^2 = .32$, Symbolic Distance and Congruency, $F(2, 130) = 44.43$, $MSE = .001$, $\eta^2 = .41$, as well as main effects of Congruency, $F(1, 65) = 227.57$, $MSE = .003$, $\eta^2 = .78$, and Symbolic Distance, $F(2, 130) = 62.98$, $MSE = .001$, $\eta^2 = .49$. These findings are qualified by the higher order interactions presented above, however, and are thus not further discussed. No other main effects or interactions were significant (largest $F = 1.70$).

In summary, the most important result for present purposes is the clear asymmetry in how the Congruency Proportion manipulation differentially modulates the Congruency effect in the Numerical and Physical Judgement tasks. Specifically, in both RTs and errors, the Congruency by Congruency Proportion interaction was significant in the Numerical Judgement task, but not the Physical Judgement task.[2]

## General Discussion

Our findings significantly extend prior research that has employed Congruency Proportion manipulations to address key aspects of processing in conflict tasks. In Stroop (e.g., Logan & Zbrodoff, 1979), Simon (e.g., Borgmann et al., 2007), and Flanker (e.g., Gratton, Coles & Donchin, 1992), the common finding is that as the proportion of congruent/compatible trials increases, so too does the magnitude of the congruency effect. Botvinick et al. (2001) have explained the effect of Congruency Proportion manipulations in terms of a *reduction* in the amount of attentional control as the proportion of congruent trials increases. That is, when there is a high proportion of trials that are congruent, the odds are that on any given trial the irrelevant dimension will provide the same response as the relevant dimension. In contrast, when the proportion of congruent trials is low, more often than not the subject will be presented with conflicting information from the relevant and irrelevant dimensions. Thus, the proportion of congruent trials can be understood as modulating the amount of conflict in the task via the attentional demands (i.e., the weighting that the subject assigns to each dimension). The reduction of attentional control in the high Congruency Proportion condition is thus proposed to allow the contribution of more fluent processes to increase. This increase leads to faster processing on congruent trials, but at the cost of slower processing on incongruent trials.

Despite the mean RT and error rates for the Numerical and Physical Judgement tasks being similar, the manipulation of Congruency Proportion had a significant effect on the Numerical Judgement task, but not the Physical Judgement task. We take these findings of asymmetric effects on type of Judgement Task to be indicative of the relative fluency of processing these two dimensions. Specifically, these data support the hypothesis that physical size information gets activated and becomes available for processing before numerical size information. Schwarz and Ischebeck's (2003) relative speed account of the Size Congruity Effect, while not making any predictions about the effect of a Congruency Proportion manipulation, provides a framework for understanding these results. The Physical Judgement task is based upon purely physical characteristics of the stimuli and uses early and fast visual processes, whereas the Numerical Judgement task requires the activation of semantics. If physical information can be extracted faster than semantic information, the expected result is that the physical size of the stimuli has more time to interfere with the judgement concerning semantic relations than vice versa. This interpretation is also consistent with developmental studies which have found that the interference effects associated with the activation of numerical magnitude information during judgements of physical size emerges gradually through child development (Rubinsten et al., 2002; Girelli et al., 2000).

In the current experiment, we examined the effect of congruency proportion at the list level. That is, congruency proportion was manipulated and analysed over a complete block of trials. As such, we have limited our discussion to how congruency proportion modulates attentional control over processing the relevant and irrelevant dimensions of the task at this more macro level. Recently, however, there has been considerable interest in the degree to which congruency proportion effects can be modulated by other experimental factors such as contextual cues (e.g., Crump, Gong, & Milliken, 2006) and specific item pairings within a list of trials (e.g., Schmidt & Besner, 2008). This latter item-specific proportion-congruency (ISPC) effect has been found in a wide range of tasks, including visual Stroop (Jacoby, Lindsay, & Hassals, 2003), auditory Stroop (Leboe & Mondor, 2007), and task switching (Leboe, Wong, Crump, & Stobbe, 2008). That is, by manipulating the congruency proportion of a limited set of items (i.e., a specific pairing of a colour word and a colour in the context of a visual Stroop task) within a block of trials that have a fixed global congruency proportion, items within the set that are mostly congruent show larger Stroop effects than those that are mostly incongruent. These effects are theoretically important as they cannot be accounted for by the adoption of more global experiment-wise strategies like those put forth in the Botvinick et al. model. As such, to account for these phenomena, more recent models have been developed that place the mechanism of control at the item level (Blais, Robidoux, Risko, & Besner, 2007; Verguts & Notebaert, 2008, 2009). Importantly, implementing control at the item level can accommodate the findings of list level congruency proportion effects, such as those found in the current manuscript. Specifically, in the context of the current experiment, rather than envisioning control as operating at the more general level of numerical size (i.e., symbolic magnitude) and physical size, control could very well be modulating attentional resources at the level of individual numerical and physical representations. How control might be manifested in such a manner, however, is a topic of much debate (see Schmidt & Besner, 2008 for a contingency learning account, and Verguts & Notebaert, 2008 for a conflict-modulated Hebbian Learning rule account).

Less central, are the findings associated with the Symbolic Distance Effect (i.e., the finding that the larger the numerical difference between two numbers, the faster the judgement). Several researchers have found that the Symbolic Distance Effect interacts differently with Size Congruity as a function of task (Schwarz & Ischebeck, 2003; Tzelgov et al., 1992). Specifically, in the Numerical Judgement task, the interaction takes the form that as the numerical distance *decreases*, the size of the congruency effect *increases*. The opposite is true of the Physical Judgement Task. Specifically, when judging physical size, as the numerical distance *decreases*, the size of the congruency effect also *decreases*. Based on the relative speed account of number-size interference proposed by Schwarz and Ischebeck (2003), decreasing the *relevant* distance, or increasing the *irrelevant* distance serves to increase the period of time during

[2] The three-way interaction between Congruency, Congruency Proportion, and Task was replicated in a second experiment ($N = 114$; $F(2, 109) = 13.3$, $MSE = 1{,}624$, $p < .001$) that included 1 Physical Distance (font sizes of 30 and 58), 5 Numerical Distances (2, 3, 4, 5, and 6 units), and 3 Congruency Proportions (.25, .50, and .75). We opted to only include the current experiment in the manuscript, however, as the Physical and Numerical Judgment Tasks are more closely equated in difficulty and thus provide a cleaner test of the asymmetries in the fluency of processing the relevant and irrelevant dimensions of the task.

which the irrelevant information has an opportunity to influence processing of the digit's relevant attribute.

The present experiment replicates this crossover interaction on RTs, and additionally shows that the effects of Congruency Proportion are likely distinct and separate from the processing that gives rise to the Symbolic Distance Effect. Specifically, although Congruency interacts with Symbolic Distance, Congruency Proportion does not (with the exception of the three way interaction between Congruency, Congruency Proportion and Symbolic Distance in error rates), suggesting that the influence of Symbolic Distance may not be modulated by attention. Further research is needed to more clearly elucidate the possible role of attention in the Symbolic Distance Effect.

## Conclusions

At the empirical level, the present data reveal that Congruency Proportion modulates the congruency effect when judging numerical size information, but not physical size information. These findings are consistent with the hypothesis that physical size information is processed before, and more fluently than, numerical size information. Theoretically, we also take this fact to further support the claim that increases in Congruency Proportion serve to reduce the relative amount of attentional control over the relevant dimension of a task. This interpretation is consistent with (1) the explanation of congruency effects in terms of the relative speed account (Schwarz & Ischebeck, 2003), and (2) the explanation of congruency proportion effects provided by Botvinick et al. (2001). Whether both of these effects (Congruency and Congruency Proportion) can be explained in terms of a single mechanism remains to be determined.

## Résumé

Quand la proportion d'essais congruents est manipulée dans les tâches conflictuelles (par ex., Stroop, Simon), les résultats typiques montrent une augmentation de la magnitude de l'effet du conflit lorsque la proportion d'essais congruents augmente. La présente expérience visait à étudier l'influence de la proportion de congruence en utilisant le paradigme de congruence de la taille. La proportion de congruence a eu une influence significative sur la tâche de jugement numérique (juger lequel de deux nombres est le plus grand numériquement), mais pas sur la tâche de jugement physique (juger lequel de deux nombres est présenté à l'aide des plus grands caractères d'impression). Ces observations appuient l'inférence selon laquelle la taille physique est traitée antérieurement à la taille numérique et de façon plus fluide que cette dernière. Les implications de cette asymétrie sont discutées en termes du rôle relatif que jouent les informations de taille physique et sémantique dans la représentation de la magnitude et du rôle qu'elles jouent dans ces deux tâches.

*Mots-clés* : distance numérique, congruence de la taille, proportion de congruence, contrôle cognitif

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Received April 5, 2010
Accepted July 20, 2010 ■

## New Editor Appointed for *Canadian Psychology*, 2012–2015

The Canadian Psychological Association is pleased to announce the appointment of a new editor for *Canadian Psychology* for a 4-year term beginning in 2012. New manuscripts should be directed to:

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