Neuroscience Letters 476 (2010) 156–160

Contents lists available at ScienceDirect

Neuroscience Letters

journal homepage: www.elsevier.com/locate/neulet

# Multiple cognitive control mechanisms associated with the nature of conflict

Chobok Kim [a], Chongwook Chung [b], Jeounghoon Kim [b,*]

[a] Department of Anatomy and Neurobiology, University of Kentucky, KY, USA
[b] School of Humanities & Social Sciences, KAIST, 373-1 Kusong-dong, Yusong-gu, Daejeon 305-701, South Korea

ARTICLE INFO

*Article history:*
Received 14 January 2010
Received in revised form 22 March 2010
Accepted 9 April 2010

*Keywords:*
Anterior cingulate cortex
Prefrontal cortex
Cognitive control
Conflict monitoring
Functional MRI

ABSTRACT

Cognitive control is required to regulate conflict. The conflict monitoring theory suggests that the dorsal anterior cingulate cortex (dACC) is involved in detecting response conflict and the dorsolateral prefrontal cortex (DLPFC) plays a critical role in regulating conflict. Recent studies, however, have suggested that rostral dACC (rdACC) responds to response conflict whereas caudal dACC (cdACC) is associated with perceptual conflict. Moreover, DLPFC has been engaged only in regulation of response conflict. A neural network involved in perceptual conflict, however, remains unclear. In this study, we used functional magnetic resonance imaging (fMRI) in an attempt to reveal monitor–controller networks corresponding to either perceptual conflict or response conflict. A version of the Stroop color matching task was used to manipulate perceptual conflict, response conflict was manipulated by an arrow. The results demonstrated that rdACC and DLPFC were engaged in response conflict whereas cdACC and the dorsal portion of premotor cortex (pre-PMd) were involved in perceptual conflict. Interestingly, the posterior parietal cortex (PPC) was activated by both types of conflict. Correlation analyses between behavioral conflict effects and neural responses demonstrated that rdACC and DLPFC were associated with response conflict whereas cdACC and pre-PMd were associated with perceptual conflict. PPC was not correlated with either perceptual conflict or response conflict. We suggest that cdACC and pre-PMd play critical roles in perceptual conflict processing, and this network is independent from the rdACC/DLPFC network for response conflict processing. We also discussed the function of PPC in conflict processing.



Cognitive control refers to the ability to configure the cognitive system to perform effortful tasks in situations where inhibition of irrelevant stimuli or representations, and amplification of relevant ones are required in information processing. It has been suggested that the prefrontal cortex (PFC) plays an important role in cognitive control [20]. One of the predominant accounts of cognitive control, the conflict monitoring theory, suggests that conflict occurs at the response level when a task requires one to override response competition [3,4]. This theory suggests that the dorsal anterior cingulate cortex (dACC) is involved in detecting response conflict and the dorsolateral prefrontal cortex (DLPFC) is engaged in resolution of conflict. Recent findings, however, suggest that conflict occurs at the perceptual (or stimulus) level as well as at the response level, and that different neural networks are involved in these different types of conflict [8,18,21,26,29].

In our earlier study, we examined brain activation for either perceptual or response conflict using the Stroop matching task, and found independent neural mechanisms involved in perceptual and response conflict processing. The caudal dACC (cdACC) activation was specific to perceptual conflict whereas the rostral dACC (rdACC) was associated only with response conflict [14]. We also found that DLPFC was activated by response conflict, but not perceptual conflict, supporting the rdACC/DLPFC network that is specific to response conflict. However, we failed to specify any PFC region other than cdACC, which might be expected to be involved in regulation of perceptual conflict (e.g., the perceptual controller). A potential explanation for this result is that cdACC is involved in both detecting and regulating perceptual conflict [14,23]. A recent study, however, proposed that multiple cognitive control mechanisms are implemented in the brain depending on the level of information processing [6]. According to Egner's hypothesis, domain specific multiple control systems comprise multiple sets of the conflict monitor–controller loops at stimulus and response levels, and each operates in parallel and are independent. In other words, distinct brain regions appear to be necessary for cognitive control at the perceptual level as well. One reason for a lack of PFC activation for perceptual conflict in our earlier study might be due to the switching effect caused by different modalities (i.e., color vs. word). We used color rectangles and words as response cues for the color-response and the word-response, respectively, in an effort to measure the two types of conflict.

Thus, it is important to test whether an independent monitor–controller network, specific to perceptual conflict, exists by using a new task design that eliminate any response switch-

* Corresponding author. Tel.: +82 42 350 4628; fax: +82 42 350 2380.
*E-mail address:* miru@kaist.ac.kr (J. Kim).

0304-3940/$ – see front matter © 2010 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.neulet.2010.04.019

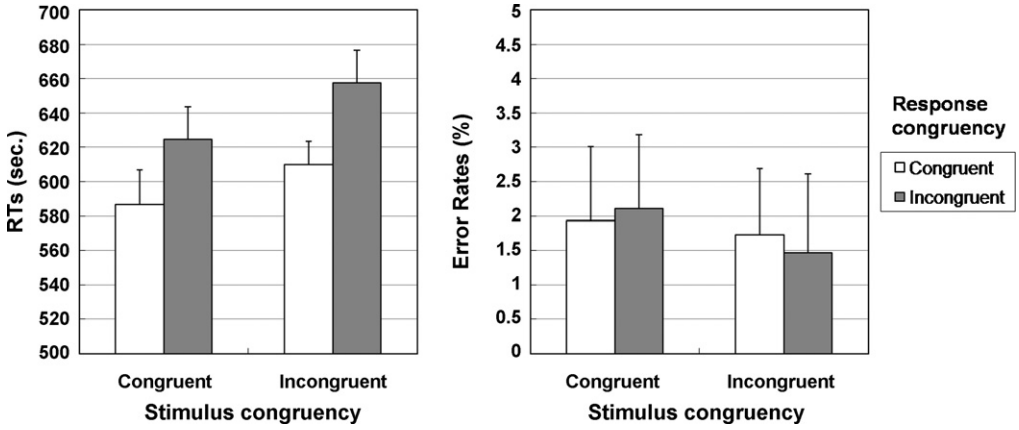


**Fig. 1.** Mean response times (RTs) and error rates. Error bars reflect mean ± standard error of the mean (SEM).

ing effects. In the current study, thus, we aimed to test whether cognitive control networks at perceptual and response levels are independent and dissociable. We designed a version of the Stroop matching task to manipulate perceptual conflict and response conflict within a single task design so that each conflict could be measured independently in a $2 \times 2$ factorial design. We expected that perceptual and response conflicts would recruit separate neural networks if multiple independent conflict-control loops are implemented in the brain. On the other hand, a positive interaction effect would be found if any cortical region was involved in the both types of conflict.

Twelve healthy right-handed volunteers (four females and eight males) ranging in age from 19 to 29 years ($M = 22.8$, SD = 3.5) participated in this study. All subjects gave informed consent and no subject had a history of any neurological problems.

We employed a version of the Stroop color matching task used in our earlier study to manipulate the conflict type at the perceptual and response levels [14]. Subjects were fully trained on the task prior to scanning. The task stimuli consisted of a color name printed in an ink color (a sample), two colored squares (response cues) and an arrow. The arrow was presented in the middle of a gray screen, and the sample and response cues were presented just above and below, respectively. The sample was presented in either a congruent (e.g., "RED" printed in red ink) or incongruent context (e.g., "RED" printed in blue ink). The color of one response cue was always the same as the sample color, and the distracter color was always different from the sample word color. This manipulation was to evoke perceptual conflict without any accompanying response conflict [14,18,19]. Four different colors (red, green, blue and yellow) were used in the sample and response cue. The sample word was either "red", "green", "blue", or "yellow" and was presented in native language (i.e., Korean). The arrow pointed either to the correct response cue (response-congruent) or to the incorrect response cue (response-incongruent) in order to evoke response conflict. This arrow manipulation has been used to measure response conflict in previous behavioral [27] and neuroimaging studies [1]. The task was comprised of four conditions; perceptual-congruent and response-congruent (PcRc), perceptual-congruent and response-incongruent (PcRi), perceptual-incongruent and response-congruent (PiRc) and perceptual-incongruent and response-incongruent (PiRi).

Subjects were instructed to match the color of the sample with the correct response cue by pressing a response button using either their index or middle finger as quickly as possible. They were also asked to fixate on the middle of the screen while the crosshair was presented between trials. The stimulus duration was 1.2 s, and was followed by an inter-stimulus-interval (average 2.7 s ranging from 1.7 to 3.7). Each experimental condition was comprised of 48 trials that were presented in random order and an equal number of null events were also included. Functional scans consisted of two runs with each run lasting for 468 s.

Functional magnetic resonance imaging (fMRI) data was acquired using a 3-T MRI system (Oxford magnet, Varian console magnet built by ISOL, fMRI center at KAIST in Daejeon, South Korea). T2*-weighted gradient echo planner images (EPI) comprised of 20 inter-leaved slices were collected (TR = 2 s, TE = 35 ms, FA = 85°, matrix = $64 \times 64$, in-plane resolution = 3.44 $mm^2$, thickness = 5 mm). Two scans were collected for the fMRI experiment and each functional time series consisted of 234 volumes. To minimize artifacts, six additional volumes were collected at the beginning of each functional scan and were discarded prior to data analyses. T1-weighted high-resolution images (MPRAGE) were also collected for all subjects.

SPM5 (Statistical Parametric Mapping; Wellcome Department of Cognitive, Institute of Neurology, UCL, London, UK) was used for preprocessing and statistical analyses. Functional images were coregistered with a high-resolution anatomical volume after temporal (the slice timing correction) and spatial disparity corrections (the head motion correction in three axes). The images were then normalized into the Montreal Neurological Institute (MNI) standard space and were spatially smoothed using a non-isotropic Gaussian kernel (full width half maximum, FWHM = 8 mm). A 128-s high-pass filter was used to remove cardio-respiratory factors. A general linear model using a canonical hemodynamic function (HRF) was used for the individual analysis. Incorrect trials were modeled into a separate regressor and only correct trials were analyzed. Contrast images were constructed by comparing each task condition (i.e., PcRc, PiRc, PcRi and PiRi) with the null events, which were then modeled into the group-level analysis. In the group analysis, two independent variables, the sample type (i.e., congruent vs. incongruent) and response type (i.e., congruent vs. incongruent), were modeled into repeated-measures two-way ANOVA. Neural responses for perceptual or response conflict were measured by either the positive main effect of the sample type or the response type, respectively. For the group analysis, we adopted the random effect model, and a threshold was applied at $p < 0.05$ using the false discovery rate for multiple comparison correction [10]. MNI coordinates were converted into the Talairach space [25] using a conversion tool [16].

Error rates and response times (RTs) were analyzed using repeated-measures two-way ANOVA (Fig. 1). The result of RTs showed that the main effect of the sample type (i.e., the perceptual conflict effect) was significant ($F(1,11) = 12.916$, MSE = 732.765, $p = 0.004$). The main effect of the response type (i.e., the response conflict effect) was also significant

**Table 1**
Brain regions significantly activated by perceptual conflict and response conflict.

| Regions | BA | L/R | *x*, *y*, *z* | *z* | Size |
|---|---|---|---|---|---|
| Perceptual conflict | | | | | |
| pre-PMd | 6 | R | 32, −7, 56 | 4.13 | 23 |
| | 6 | L | −27, −7, 57 | 4.43 | 51 |
| cdACC | 24/32 | L | −10, 15, 38 | 3.75 | 80 |
| IPL/SPL | 7/40 | L | −21, −65, 41 | 5.35 | 436 |
| | 7/40 | R | 26, −68, 47 | 5.16 | 357 |
| Response conflict | | | | | |
| rdACC | 32/8 | R | 4, 22, 40 | 4.83 | 154 |
| DLPFC | 6/9 | R | 38, 4, 27 | 4.20 | 191 |
| | 9/46 | L | −40, 24, 28 | 4.00 | 342 |
| IPL/SPL | 7/40 | L | −43, −46, 51 | 4.98 | 111 |
| SPL | 7 | R | 15, −63, 55 | 4.83 | 277 |
| Putamen | | R | 24, 22, −4 | 4.75 | 28 |

($F(1,11) = 15.620$, MSE = 1398.561, $p = 0.002$). Specifically, the perceptual and response conflict effects were 28.08 ms and 42.67 ms, respectively. In contrast, the interaction between the sample type and response type was not significant ($F(1,11) = 0.404$, MSE = 693.288, $p = 0.538$). In addition, no effect was observed in the analysis of error rates ($ps > 0.42$).

Functional imaging data were analyzed using repeated-measures two-way ANOVA to show perceptual and response conflicts independently, and to identify any cortical region involved in both types of conflict. As shown in Table 1 and Fig. 2, cdACC (Brodmann area, BA 24/32), bilateral Pre-PMd (BA 6), and posterior parietal cortex (PPC, BA 7/40) were associated with perceptual conflict, rdACC (BA 32/8), bilateral DLPFC (BA 6/9/46), PPC (BA 7/40) and right putamen were associated with response conflict. As depicted in Fig. 2, PPC was activated by both conflict types. A conjunction analysis confirmed that bilateral PPC areas (BA 7/40, centered at −43, −46, 51 and 26, −65, 44) were the only regions commonly involved in both types of conflict. However, no region was found in the interaction effect which reflects the engagement in both types of conflict. We depicted BOLD signal changes of the voxels showing peak activation within regions of interest (ROIs) for each experimental condition. These were extracted from DLPFC and rdACC activated by response conflict, pre-PMd and cdACC activated by perceptual conflict, and PPC activated by both conflict types.

To test the relationship between behavioral and neural responses, we carried out correlation analyses between two behavioral conflict effects and the peak values of BOLD signal changes of ROIs (i.e., cdACC, rdACC, pre-PMd, DLPFC and PPC) for PcRi, PiRc and PiRi. The results demonstrated that when the task condition contained a perceptual-incongruent component (i.e., PiRc and PiRi), cdACC and pre-PMd were significantly correlated with the perceptual conflict effect. In contrast, rdACC and DLPFC were associated with the response conflict effect when the task condition included a response-incongruent component (i.e., PcRi and PiRi). Although some of these correlations were only significant at the uncorrected level, they showed clear dissociations (Table 2). Interestingly, bilateral PPC regions were not associated with either the perceptual conflict effect or the response conflict effect even though these regions showed strong activations for both (see Table 1 and Fig. 2).

We examined whether cognitive control networks are associated with the level of information processing independently. Specifically, we combined perceptual and response conflicts into a single task design using a modified version of the Stroop task to compare brain activations during conflict processing evoked by perceptual and response conflicts. Behavioral data demonstrated that the two types of conflict associated with perceptual and response levels were independent. Perceptual conflict was induced simply when subjects were required to select a color while ignoring a word [24], whereas response conflict was observed when responses were distracted by an arrow pointing to the opposite direction [1].

Functional imaging data demonstrated that response conflict recruited the rdACC/DLPFC network. This is consistent with the conflict monitoring hypothesis, in which this network plays a critical role in detecting and regulating response conflict [3,5,13]. In addition, we found another neural network including cdACC and pre-PMd, which is specific to perceptual conflict processing. The finding of cdACC activation during perceptual conflict processing supports previous studies that found cdACC recruitment in monitoring of perceptual conflict [14,18,26]. An important finding of this study was pre-PMd recruitment during perceptual conflict processing. Functional neuroimaging studies have suggested that the role of pre-PMd is not restricted to motor control, but is extended to cognitive control [2,11] or attentional control [12] even when there is no demand of motor control. Thus, it is interpreted that, together with cdACC, pre-PMd is involved in cognitive control at the perceptual level.

Important questions of this study were whether multiple conflict-driven cognitive control networks exist in the brain, and if so, whether they are independent according to the processing level. Whole brain analyses demonstrated that these two networks are independent. In addition, ROI analyses showed that BOLD signal changes in cdACC and pre-PMd were correlated only with the perceptual conflict effect whereas changes in rdACC and DLPFC were associated only with the response conflict effect. These findings support the multiple conflict-driven cognitive control hypothesis in which cognitive control systems are implemented in the brain according to the level of information processing [7].

Interestingly, however, pre-PMd activation for perceptual conflict was not found in our previous study [14]. We found rdACC and DLPFC activations for response conflict and cdACC activation for perceptual conflict, but pre-PMd was not involved in perceptual conflict. One potential explanation for this discrepancy between

**Table 2**
Correlations between behavioral conflict effects and neural responses. Note that ROIs were functionally defined based on the whole brain analysis.

| Trial type | Behavioral responses | Brain regions of interest | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | cdACC | rdACC | DLPFC | | pre-PMd | | PPC | |
| | | | | L | R | L | R | L | R |
| PcRi | Perceptual conflict | 0.31 | −0.12 | −0.33 | −0.32 | 0.28 | 0.23 | 0.03 | 0.01 |
| | Response conflict | 0.31 | **0.73**$^{**}$ | **0.82**$^{***}$ | **0.78**$^{**}$ | 0.08 | 0.26 | −0.18 | 0.27 |
| PiRc | Perceptual conflict | **0.75**$^{**}$ | 0.07 | 0.08 | 0.32 | **0.62**$^{*}$ | **0.76**$^{**}$ | 0.12 | 0.12 |
| | Response conflict | −0.40 | −0.16 | 0.27 | 0.21 | −0.05 | −0.03 | 0.04 | 0.02 |
| PiRi | Perceptual conflict | **0.81**$^{***}$ | 0.32 | −0.38 | −0.24 | **0.76**$^{**}$ | **0.80**$^{***}$ | −0.07 | 0.01 |
| | Response conflict | −0.25 | **0.70**$^{*}$ | **0.66**$^{*}$ | **0.72**$^{*}$ | −0.03 | 0.20 | 0.29 | 0.37 |

$^{*}$ The correlation coefficient is significant at $p < 0.05$, uncorrected.
$^{**}$ The correlation coefficient is significant at $p < 0.10$, corrected.
$^{***}$ The correlation coefficient is significant at $p < 0.05$, corrected.

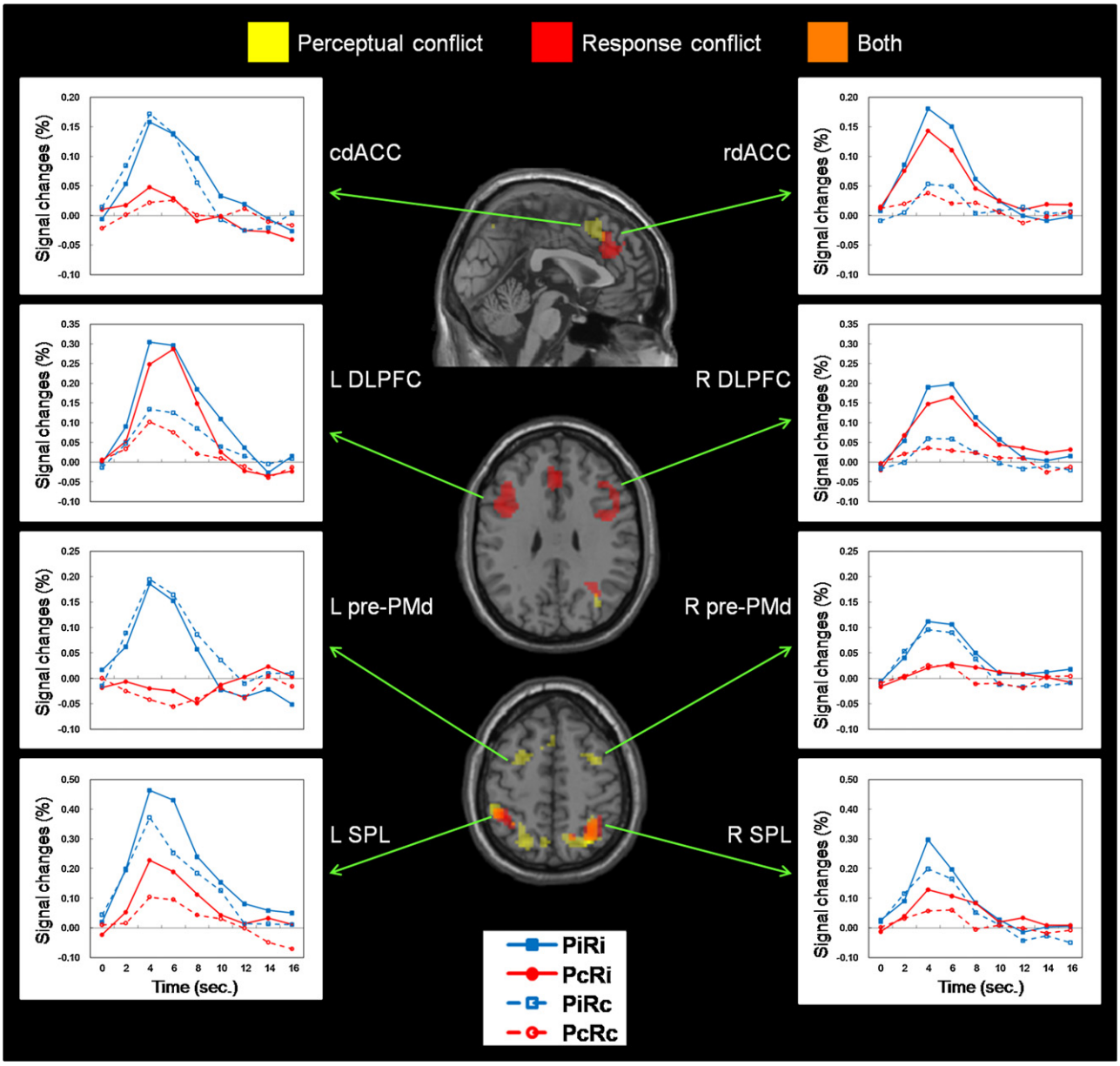


**Fig. 2.** Brain activation map thresholded at $p < 0.05$ (corrected) and BOLD signal changes of each trial type from the regions of interest (ROIs).

the current finding and the previous study is that the previous task design might include a switch component between response modalities, where we employed different response cues (i.e., color- and word-responses) to measure perceptual and response conflicts. This explanation is supported by a previous task-switching study [17]. Liston et al. found pre-PMd activation when subjects were to switch between color and motion (or vice versa). However, a switching effect was eliminated as subjects were only required to respond to the color domain.

Another interesting finding was that we found bilateral parietal activation for both conflict types. Indeed, broader regions of PPC were activated by perceptual conflict than response conflict (see Fig. 2). This seems to be consistent with previous studies that suggest PPC involvement in cognitive control at the perceptual level [7,17]. However, the tasks used in these studies might have limitations. For example, Liston et al. employed a perceptual detection task using color and motion domains, and thus PPC activation could be caused by motion processing [17]. Furthermore, Egner et al. suggested that PPC is involved in regulation of stimulus-based conflict, but the task condition for stimulus-based conflict included a response conflict component as well [7]. In detail, their task was to select a response button in the stimulus-based conflict condition, in which the button had been already assigned according to color (i.e., left for green and right for red). Thus, the stimulus-based conflict condition (e.g., "GREEN" printed in red) might be associated with response conflict as well. Indeed, the task condition for stimulus- and response-based conflicts focused on the origin of the conflicts, not on the level of processing, as they described in their study.

Alternatively, PPC may be involved in both types of conflict, as a part of a domain-general conflict network. However, PPC was not correlated with behavioral measurements for both types of conflict (see Table 2). Thus, we suggest that PPC may be involved in domain-general attentional control [28,30] or orienting attention to the relevant feature of the stimulus [9,22]. However, it is important to note here that correlations between imaging and behavioral data were based on non-independent ROI selection (i.e., ROIs were functionally defined) even though the correlation analyses demonstrated clear dissociations within frontal and PPC regions [15].

According to the multiple conflict-driven cognitive control hypothesis, it is assumed that multiple monitor–controller systems are implemented in the brain according to the level of processing [6]. Based on the current results, we suggest that two distinct cognitive control networks are associated with the nature of conflict. The rdACC/DLPFC network is specific to response conflict, whereas the cdACC/pre-PMd network is involved in perceptual conflict. Consistent with previous studies, the current findings support the conflict monitoring hypothesis in which rdACC plays a critical role in monitoring response conflict, whereas DLPFC is involved in response conflict regulation. With the current task design, however, it is impossible to specify the functions (i.e., detection and resolution) of cdACC and pre-PMd. Thus, in order to integrate the current findings into the multiple conflict-driven cognitive control hypothesis, further studies are required to directly test the functional dissociation of cdACC and pre-PMd in perceptual conflict processing.

## Acknowledgements

This research was supported by the Converging Research Center Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2009-0082262).

## References

[1] E. Aarts, A. Roelofs, M. van Turennout, Attentional control of task and response in lateral and medial frontal cortex: brain activity and reaction time distributions, Neuropsychologia 47 (2009) 2089–2099.
[2] M. Abe, T. Hanakawa, Y. Takayama, C. Kuroki, S. Ogawa, H. Fukuyama, Functional coupling of human prefrontal and premotor areas during cognitive manipulation, J. Neurosci. 27 (2007) 3429–3438.
[3] M.M. Botvinick, T.S. Braver, D.M. Barch, C.S. Carter, J.D. Cohen, Conflict monitoring and cognitive control, Psychol. Rev. 108 (2001) 624–652.
[4] M.M. Botvinick, J.D. Cohen, C.S. Carter, Conflict monitoring and anterior cingulate cortex: an update, Trends Cogn. Sci. 8 (2004) 539–546.
[5] M.M. Botvinick, L.E. Nystrom, K. Fissell, C.S. Carter, J.D. Cohen, Conflict monitoring versus selection-for-action in anterior cingulate cortex, Nature 402 (1999) 179–181.
[6] T. Egner, Multiple conflict-driven control mechanisms in the human brain, Trends Cogn. Sci. 12 (2008) 374–380.
[7] T. Egner, M. Delano, J. Hirsch, Separate conflict-specific cognitive control mechanisms in the human brain, NeuroImage 35 (2007) 940–948.
[8] T. Egner, J. Hirsch, The neural correlates and functional integration of cognitive control in a Stroop task, NeuroImage 24 (2005) 539–547.
[9] J. Fan, J.I. Flombaum, B.D. McCandliss, K.M. Thomas, M.I. Posner, Cognitive and brain consequences of conflict, NeuroImage 18 (2003) 42–57.
[10] C.R. Genovese, N.A. Lazar, T. Nichols, Thresholding of statistical maps in functional neuroimaging using the false discovery rate, NeuroImage 15 (2002) 870–878.
[11] T. Hanakawa, M. Honda, N. Sawamoto, T. Okada, Y. Yonekura, H. Fukuyama, H. Shibasaki, The role of rostral brodmann area 6 in mental-operation tasks: an integrative neuroimaging approach, Cereb. Cortex 12 (2002) 1157–1170.
[12] J.B. Hopfinger, M.H. Buonocore, G.R. Mangun, The neural mechanisms of top-down attentional control, Nat. Neurosci. 3 (2000) 284–291.
[13] J.G. Kerns, J.D. Cohen, A.W. MacDonald III, R.Y. Cho, V.A. Stenger, C.S. Carter, Anterior cingulate conflict monitoring and adjustments in control, Science 303 (2004) 1023–1026.
[14] C. Kim, J.K. Kroger, J. Kim, A functional dissociation of conflict processing within anterior cingulate cortex, Hum. Brain Mapp., in press.
[15] N. Kriegeskorte, W.K. Simmons, P.S.F. Bellgowan, C.I. Baker, Circular analysis in systems neuroscience: the dangers of double dipping, Nat. Neurosci. 12 (2009) 535–540.
[16] J.L. Lancaster, D. Tordesillas-Gutierrez, M. Martinez, F. Salinas, A. Evans, K. Zilles, J.C. Mazziotta, P.T. Fox, Bias between MNI and Talairach coordinates analyzed using the ICBM-152 brain template, Hum. Brain Mapp. 28 (2007) 1194–1205.
[17] C. Liston, S. Matalon, T.A. Hare, M.C. Davidson, B.J. Casey, Anterior cingulate and posterior parietal cortices are sensitive to dissociable forms of conflict in a task-switching paradigm, Neuron 50 (2006) 643–653.
[18] M.P. Milham, M.T. Banich, Anterior cingulate cortex: an fMRI analysis of conflict specificity and functional differentiation, Hum. Brain Mapp. 25 (2005) 328–335.
[19] M.P. Milham, M.T. Banich, A. Webb, V. Barad, N.J. Cohen, T. Wszalek, A.F. Kramer, The relative involvement of anterior cingulate and prefrontal cortex in attentional control depends on nature of conflict, Cogn. Brain Res. 12 (2001) 467–473.
[20] E.K. Miller, J.D. Cohen, An integrative theory of prefrontal cortex function, Annu. Rev. Neurosci. 24 (2001) 167–202.
[21] J.M. Orr, D.H. Weissman, Anterior cingulate cortex makes 2 contributions to minimizing distraction, Cereb. Cortex 19 (2009) 703–711.
[22] S.M. Ravizza, C.S. Carter, Shifting set about task switching: behavioral and neural evidence for distinct forms of cognitive flexibility, Neuropsychologia 46 (2008) 2924–2935.
[23] A. Roelofs, M. van Turennout, M.G.H. Coles, Anterior cingulate cortex activity can be independent of response conflict in Stroop-like tasks, Proc. Natl. Acad. Sci. 103 (2006) 13884–13889.
[24] M.J. Sugg, J.E. McDonald, Time course of inhibition in color-response and word-response versions of the Stroop task, J. Exp. Psychol. Hum. Percept. Perform. 20 (1994) 647–675.
[25] J. Talairach, P. Tournoux, Co-planar Stereotaxic Atlas of the Human Brain, Thieme Medical Publishers, New York, 1988.
[26] V. van Veen, C.S. Carter, Separating semantic conflict and response conflict in the Stroop task: a functional MRI study, NeuroImage 27 (2005) 497–504.
[27] F. Verbruggen, B. Liefooghe, W. Notebaert, A. Vandierendonck, Effects of stimulus–stimulus compatibility and stimulus-response compatibility on response inhibition, Acta Psychol. 120 (2005) 307–326.
[28] T.D. Wager, J. Jonides, S. Reading, Neuroimaging studies of shifting attention: a meta-analysis, NeuroImage 22 (2004) 1679–1693.
[29] D.H. Weissman, B. Giesbrecht, A.W. Song, G.R. Mangun, M.G. Woldorff, Conflict monitoring in the human anterior cingulate cortex during selective attention to global and local object features, NeuroImage 19 (2003) 1361–1368.
[30] E. Wojciulik, N. Kanwisher, The generality of parietal involvement in visual attention, Neuron 23 (1999) 747–764.