Supplementary Material Online

Bilingual advantage in executive control when task demands are considered

LI QU
Nanyang Technological University, Singapore
JOEL JIA WEI LOW
Nanyang Technological University, Singapore
TING ZHANG
South West University, China
HONG LI
South West University, China
PHILIP DAVID ZELAZO
University of Minnesota, USA

Appendix

Performance on the Mixed-repeat Trials in the Mixed-task Blocks

Two separate 2 (suppression demand) × 2 (activation demand) × 2 (language group) ANOVAs were conducted on the ACCs and CRTs for the mixed-repeat trials in the Mixed-task blocks. Results (see Figure 2) showed a significant effect of language group on ACCs ($F(1, 62) = 5.022$, $p < .05$, $\eta_p^2 = .075$). Additionally, there was a significant interaction effect between the suppression demand, the activation demand, and language group ($F(1, 62) = 8.868$, $p < .01$, $\eta_p^2 = .125$). Further multivariate analyses showed that the interaction between the suppression demand and the activation demand was only significant among monolinguals ($F(1, 31) = 8.003$, $p < .01$, $\eta_p^2 = .205$) not among bilinguals ($F(1, 31) = 2.045$, $p > .05$, $\eta_p^2 = .062$). The interaction between the suppression demand and the activation demand in the monolinguals was further analyzed by separately examining the activation demand with and without suppressing conflicting responses. When there was no need to suppress conflicting responses as in the S∈Ac and S∈A∈ versions, there was a significant activation effect ($F(1, 31) = 6.067$, $p < .05$, $\eta_p^2 = .164$), indicating that monolinguals were significantly more accurate when they needed to activate

conflicting responses as in the S⊖Ac version than when they needed to activate non-conflicting responses as in the S⊖A⊖ version (d = .07); However, the significant effect of activation demand disappeared when the participants needed to suppress conflicting responses as in the Sc A⊖ and Sc Ac changes (F(1, 31) = 1.303, p > .05, η_p^2 = .040). Furthermore, language group differences only appeared when participants needed to suppress one set of conflicting responses without simultaneously activating the other set of conflicting responses as in the Sc A⊖ (F(1, 62) = 6.845, p < .05, η_p^2 = .099) and when participants needed to activate one set of conflicting responses without simultaneously suppressing the other set of conflicting responses as in the S⊖Ac versions (F(1, 62) = 7.222, p < .01, η_p^2 = .104): Bilinguals were more accurate than monolinguals (d = .09; d = .10) in these two versions.

In terms of CRTs, there was a significant language group difference (F(1, 62) = 6.997, p = .01, η_p^2 = .101), showing that bilinguals responded significantly slower than monolinguals in general (d = .04). Additionally, there was a significant suppression demand effect (F(1, 62) = 36.504, p < .001, η_p^2 = .371), indicating that all participants were significantly slower when there were conflicting responses to suppress (d = .03).

In summary, during the mixed-repeat trials, all participants, regardless of language group, when they needed to suppress conflicting responses, they performed slower compared to when they only suppressed non-conflicting responses. Furthermore, among monolinguals, there was a significant interaction between the suppression demand and the activation demand. Additionally, bilinguals were also slower than monolinguals across all the versions though they were more accurate on the Sc A⊖ and S⊖Ac versions.

Performance on the Switch Trials in the Mixed-task Blocks

Two separate (suppression demand) × 2 (activation demand) × 2 (language group) ANOVAs were conducted on the ACCs and CRTs for the switch trials in the Mixed-task blocks. Results (see Figure 2) showed a significant main effect of suppression demand (ACCs: $F(1, 62) = 57.537$, $p < .001$, $\eta_p^2 = .481$; CRTs: $F(1, 62) = 17.372$, $p < .001$, $\eta_p^2 = .219$), indicating that participants performed significantly less accurate ($d = -.28$) and slower ($d = .04$) when they needed to suppress primed conflicting responses as in the ScAϵ and ScAc versions compared to when they needed to suppress novel responses as in the SϵAϵ and SϵAc versions. Furthermore, there were significant interactions between the suppression demand and the activation demand (ACCs: $F(1, 62) = 51.770$, $p < .001$, $\eta_p^2 = .455$; CRTs: $F(1, 62) = 10.098$, $p < .01$, $\eta_p^2 = .140$). Further analyses by separating the suppression demand showed that when the participants only needed to suppress non-conflicting responses as in the SϵAϵ and SϵAc versions, there was a significant activation demand effect (ACCs: $F(1, 62) = 19.145$, $p < .001$, $\eta_p^2 = .236$; CRTs: $F(1, 62) = 6.220$, $p < .05$, $\eta_p^2 = .091$), indicating that participants performed more accurate ($d = 25$) and faster ($d = .03$) when participants needed to activate conflicting responses as in the SϵAc version than when they needed to activate non-conflicting responses as in the SϵAϵ version. Although the activation demand effect was still significant, when they needed to suppress conflicting responses as in the ScAϵ and the ScAc versions, the pattern was reversed: Participants performed less accurate ($F(1, 62) = 29.834$, $p < .001$, $\eta_p^2 = .325$, $d = -.28$) and slower ($F(1, 62) = 5.216$ $p < .05$, $\eta_p^2 = .078$, $d = .02$) when they needed to activate conflicting responses as in the ScAc version compared to when they needed to activate non-conflicting responses as in the ScAϵ version. Additionally, the results showed a significant main effect of language group on ACCs ($F(1, 62) =$

13.529, $p < .001$, $\eta_p^2 = .179$) but not on CRTs ($F < 1$), indicating that bilinguals were significantly more accurate than monolinguals ($d = .18$).

In summary, during the switch trials, regardless of language group, participants were less accurate and slower when the suppression demand increased. Furthermore, the significant interaction between suppression demand and activation demand appeared in both monolinguals and bilinguals. Additionally, bilinguals were significantly more accurate than monolinguals, though they performed similarly fast as monolinguals. Taken together, among the all-repeat trials of the single-task blocks, the mixed-repeat trials of the mixed-task blocks, and the switch trials of the mixed-task blocks, bilinguals only reliably outperformed monolinguals during the switch trials of the mixed-task blocks as compared to monolinguals, they were equally fast but more accurate. During the all-repeat and the mixed-repeat trials, although bilinguals were more accurate, they were also slower compared to monolinguals.