Effects of Emergent Bilingualism on the Cognitive Control of Four-Year-Old Children.

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Background: The effects of bilingualism on cognitive control have been significantly debated. A number of studies report better cognitive performance in bilinguals in Executive Function (EF) and Statistical Learning (SL) (Abutalebi et al., 2013; Barac et al., 2016; Bonifacci et al., 2011; Kuo & Anderson, 2012), yet others dispute the existence of any advantage (Duñabeitia et al., 2014; Paap et al., 2014; Yim & Rudoy, 2013). The lack of consensus is due to inconsistent experimental instantiation of key constructs. Bilingualism is viewed as a binary rather than a continuous variable, with researchers drawing an artificial dichotomy between monolinguals and bilinguals, who inevitably differ on more aspects than just the languages they use (Kaushanskaya & Prior, 2015). Many studies assess young adults with ceiling performances, making differences difficult to detect (Valian, 2015). The relationship between EF, SL and bilingualism may be more robust during childhood when both language and cognition are rapidly maturing. Furthermore, studies measuring EFs often use very few tasks, failing to capture the complexity of these processes (Friedman et al., 2008). Finally, the effects of bilingualism on SL are still very obscure, as researchers suggest that observed improvements simply reflect better EF (Bulgarelli et al., 2019). In sum, literature suffers from inadequate measuring and modelling of both bilingualism and cognitive processing.

Aim: We aim to identify the influence of emerging bilingualism on the EF and SL skills of four-year-old children and elucidate the relationship of the three.

Method: Two groups of Greek preschool children, a control ($N = 38$, $M = 49.8$ months, $SD = 3.51$) and an experimental group ($N = 40$, $M = 50.8$, $SD = 3.34$), were tested longitudinally at two points in time, seven months apart. Between testing sessions, the experimental group received second language (L2) (English) training as part of their school curriculum, whereas children in the control group attended kindergartens that did not offer English. We developed multiple tasks to measure performance in three core EF components [Inhibition, Working Memory (WM), Cognitive Flexibility (CF)] as accurately as possible, and controlled for verbal and non-verbal intelligence. We also adapted and used a novel complex SL task (namely Structure Learning), presenting children with probabilistic, stochastic sequences. The tasks were administered twice, pre and post L2 learning. Linear mixed-effects regression models were used to measure the effects of group on Difference (Δ) in performance between Phase 1 and Phase 2. Further regression models were used to evaluate more nuanced effects of L2 input and L2 proficiency. Finally, we assessed the directness of L2 learning effects on SL.

Results: A significant effect of group on Difference (Δ) in performance between Phase 1 and Phase 2 in certain CF and WM tasks was found ($p < .05$), with the experimental group performing significantly better. Specific effects of L2 input and proficiency were detected, which were not equivalent in all of the tasks. We also showed that effects of L2 learning on SL were over and above those contributed by EF improvement. Our rich cognitive battery demonstrated that the effect of L2 learning was not omnipresent, highlighting that the cognitive processes in question are complex and not equally susceptible to language-related training.

Conclusions: Effects of L2 learning on the cognitive performance of young children were detected, even after short L2 exposure. Our study offers evidence of training-related brain plasticity in EF and SL, which is valuable for designing effective developmental interventions. The effect was not ubiquitous, illustrating the complexity of these cognitive processes and the need for multiple tasks to measure them reliably.

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