A bilingual threshold for enhanced executive functioning: Cognitive advantages in Frisian-Dutch bilingual children

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**DOES MULTILINGUAL COMPETENCE INFLUENCE COGNITIVE CONTROL SKILLS ALREADY SINCE CHILDHOOD? An er-fMRI follow-up study in multilingual children**

Virginia Borsa, Pasquale A. Della Rosa, Matteo Canini, Gerda Videsott, Rita Franceschini and Jubin Abutalebi
Poster 21-May

"Recent neuro-imaging evidence in literature showed that lifelong experience in dealing with two or more languages may lead to a neuro-cognitive advantage and a lifelong positive impact on the brain. Behaviorally there are studies showing that bilingual children outperform monolinguals on task measuring executive functioning skills (Bialystok et al., 2012), while structurally Della Rosa et al. (2013) have highlighted the relationship between grey matter changes in the left inferior parietal lobule and the interaction between the natural development of a multilingual competence and the capacity to resolve cognitive conflicts. As to fMRI studies, Abutalebi et al. (2011) reported that bilingual adults not only resolve cognitive conflicts with less neural activity but their brain seems also to be better tuned to monitoring cognitive conflicts. However, an unresolved question concerns the neural development of this neurocognitive advantage and whether it is influenced by a multilingual competence in terms of degree of language proficiency.

For this purpose, in a longitudinal event-related functional magnetic resonance imaging (er-fMRI) study, we investigated the effects of linguistic competence (i.e., as a measure of proficiency) on the executive control attentional network through an ANT task (Fan et al., 2005). Fifteen multilingual Ladin-German-Italian-English children (10 boys, 5 girls) (mean age = 9.86; SD= 1.44 years) from South Tyrol, Italy, participated in the study (mean scan interval (T1-T2) = 0.97 years, SD = 0.1 years). Global multilingual competence was calculated for each participant based on the mean value of the school marks related to all languages and the total school outcome.

Slice-timing, coregistration, realignment, unwarping and noise removal processes on all functional data for both time-periods was performed prior to longitudinal subject-specific normalization and smoothing through SPM8. Conflict effect of the ANT was computed as the contrast coding the difference between Incongruent and Congruent trials at both T1 and T2, and subsequently we created differential subject-specific contrast images (T2-T1) for conflict effect-related brain activity and performed correlations with the multilingual competence differential scores (T2-T1).

fMRI data analysis revealed that lower levels of multilingual competence at T2 correlated with higher functional brain activity in the left dorsolateral frontal cortex, the head of left caudate nucleus and the left putamen, which all have been found to contribute to executive control functions in both attentional and language domains (Abutalebi & Green, 2007). These results suggest that precursors of the neurocognitive advantage exhibited by multilingual adults with respect to their monolingual peers in many studies (Bialystok, 2012) may already be pinpointed at an early neural developmental stage."

**A bilingual threshold for enhanced executive functioning: Cognitive advantages in Frisian-Dutch bilingual children**

Evelyn Bosma, Elma Blom and Arjen Versloot
Poster 21-May

"Previous research has shown that bilingual children outperform monolingual children on executive function (EF) tasks that test interference inhibition (Martin-Rhee & Bialystok, 2008; Engel de Abreu et al., 2012), selective attention (Engel de Abreu et al., 2012) and working memory (Blom et al., 2014; Morales et al., 2013). Recent studies have challenged bilingual children's EF advantages (Duñabeitia et al., 2014; Paap & Green, 2013), pointing to the confounding effect of demographic differences between bilinguals and monolinguals. The current study investigates a new population of bilinguals: speakers of the national majority language Dutch and the regional minority language Frisian. While other studies comparing bilinguals in a similar setting investigated two very different languages, e.g., Welsh-English (Gathercole et al, 2010) and Basque-Spanish (Duñabeitia et al., 2014), Frisian and Dutch are closely related. All children are selected from the same population of bilingual Frisian-Dutch children, which minimizes the risk of confounding variables. At the same time, the bilingual Frisian-Dutch children vary substantially in their degree of bilingualism, which allows investigating whether enhanced EFs require a bilingual threshold (Blom et al. 2014; Carlson & Meltzoff, 2008; Poarch & Van Hell, 2012).

In order to examine if (i) bilingual Frisian-Dutch children have enhanced EFs, and (ii) EF enhancement is related to the degree of bilingualism, we tested 25 Frisian-Dutch balanced bilinguals and 25 Dutch-dominant children on interference inhibition, selective attention and verbal and visuospatial working memory. The two groups were matched on age (5-6 year olds), nonverbal IQ (WNV; Wechsler & Naglieri, 2006), socioeconomic status, Dutch expressive..."
morphology (Taaltoets Alle Kinderen, Verhoeven & Vermeer, 2002) and receptive vocabulary (Peabody Picture Vocabulary Test-III-NL, Dunn & Schlichting, 2005). Frisian expressive morphology and receptive vocabulary were assessed with tasks modelled after the Dutch tasks. The balanced bilinguals scored similarly on Dutch and Frisian morphology, t(24)=1.24, p=.23, and vocabulary, t(24)=-0.56, p=.58, while the Dutch-dominant bilinguals scored better on the Dutch than on the Frisian versions of these two tasks, t(24)=-16.56, p<.001 for morphology, t(24)=-5.15, p<.001 for vocabulary.

A one-way multivariate analysis of variance (MANOVA) revealed a statistically significant difference in EF performance between the balanced bilinguals and the Dutch-dominant bilinguals, F(4,45)=2.59, p<.05, η²=.19. Subsequent ANOVAs (see Table 1) showed that the balanced bilinguals outperformed the Dutch-dominant bilinguals on selective attention. The balanced bilinguals also performed better than the Dutch-dominant bilinguals on verbal working memory and interference inhibition, but these differences did not reach statistical significance. There was no difference between the two groups on visuospatial working memory.

In this study, two bilingual Frisian-Dutch groups were compared that are demographically very similar but different in how bilingual they are. First, the results of this highly constrained study confirm that bilingualism enhances children’s EF development, although some variation was observed between the different EF tasks. Second, the findings demonstrate that a specific threshold in bilingual proficiency needs to be reached before the bilingual EF advantage takes full effect."

"Many studies have found that determining whether two words rhyme results in the electrophysiological rhyming effect (RE), a more negative N450 mean amplitude to nonrhyming than rhyming targets [1, 2]. The RE is sensitive to orthographic overlap between rhyming words, being larger for orthographically dissimilar than similar pairs [3]. The RE has also been observed during visual rhyme judgments cross-linguistically, in native speakers of languages with differing orthographic depths (i.e., how reliably spellings map to sounds) [4] such as English [deep; 5-8], Chinese [deep; 9], and Spanish [shallow; 10]. In English, comparable REs have been reported in word and pseudoword pairs [6], suggesting that rhyme activation may proceed similarly whether the reader relies on large units, or “grain sizes”, to read known words or smaller units to decode unknown words. However, we do not know if this flexible grain size [11] found in skilled English readers (with a deep, alphabetic orthography) would be observed in skilled readers of a logographic language such as Chinese, who may come to rely on large (word-level) units because they do not have the option of decoding [12], or in skilled readers of a shallow orthography such as Spanish, who may find it efficient to rely on small (letter/syllable-level) units [13, 14].

In the current work we investigated whether first language (L1) orthographic depth and grain size preferences modulate the RE in second language (L2) English speakers, as compared to English monolinguals. English monolinguals (N=29) and highly proficient, but L1–dominant, Spanish-English (N=22) and Chinese-English (N=24) bilinguals made visual rhyme judgments of semantically unrelated English word pairs, while behavioral and EEG measures were recorded. REs were evaluated for both orthographically dissimilar (e.g., WHITE–FIGHT, CHILD–COUGH) and similar (e.g., RIGHT–FIGHT, DOUGH–COUGH) pairs. In orthographically dissimilar trials, all groups responded more accurately to nonrhyming conditions, and monolinguals were overall more accurate than bilinguals. Chinese-English bilinguals were markedly faster in making nonrhyming than rhyming decisions, while the other groups did not show a latency difference between conditions. In orthographically similar conditions, all groups responded faster and more accurately to rhyming trials. Monolinguals were faster and more accurate than bilinguals; Chinese-English bilinguals were slower than Spanish-English bilinguals. All groups showed more negative N450 mean amplitudes to nonrhyming than rhyming targets regardless of orthographic similarity. However, in orthographically dissimilar conditions, the RE was more robust in monolinguals than in Chinese-English bilinguals, while Spanish-English bilinguals were intermediate to (and not different from) either group. This finding suggests that the amplitude of the ERP response to phonological mismatch in orthographically dissimilar conditions may be affected by differences between L1-L2 scripts. Alternately, the RE in these conditions may index proficiency, as it was largest for the group with the highest English proficiency self-ratings (English