Cognitive cost of two- and single digit transcoding in the second language of math learning in bilinguals of different ages

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Introduction

Transcoding from visual to verbal number symbols strongly relies on language proficiency. For bilinguals, transcoding can be performed into two different languages, leading to the question how bilinguals transcode two-digit and single digit numbers in each of their language?

Methods

We evaluated the transcoding of two- and one-digit numbers, in different age groups of bilinguals, in German and French. In the Luxembourgish educational system, children learn mathematics in German ($LL1^{math}$) until the 7^{th} grade, and then the language of mathematic learning switches to French ($LL2^{math}$). Transcoding was evaluated with a symbolic visual (i.e. digits) to verbal (i.e. number words) production task. Stimuli were two-digits below 60 in all age groups (i.e. 5^{th}, 8^{th}, 11^{th} graders and adults) and single digits only in adults. Effect sizes (*d*) of the differences between German and French production time were computed.

Results:

Effects sizes ranged from .46 to 1.82 *i.e.* medium to very large. All age groups showed a consistent cost for two digit numbers transcoding in French, *i.e.* $LL2^{math}$. Interestingly, when single digit transcoding was additionally tested in adults, we observed an effect size cost in $LL2^{math}$, which was comparable to the one obtained with two-digit numbers.

Discussion

Visual to verbal transcoding involves a cost in $LL2^{math}$. The cost is persistent over development, for two- and for single digits. These transcoding costs may be the source of worse $LL2^{math}$ arithmetic performances, even for highly proficient bilinguals (Van Rinsveld et al., 2015). This study supports the existence of strong links between numbers and language.

References:

Van Rinsveld, A., Brunner, M., Landerl, K., Schiltz, C., & Ugen, S. (2015). The relation between language and arithmetic in bilinguals: Insights from different stages of language acquisition. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00265