# Early sign-speech bilingualism helps children learn reading

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A prevailing assumption in science and society is that learning to read requires sound.[1] Yet, deaf signing children without access to sound still become successful readers.[2] Decades of research have shown similarities between spoken and sign phonological processing in the brain[2], as well as cognitive-behavioral benefits in bilingualism.[3–7] **Does sign-speech bilingualism impact learning to read?** In a cross-sectional study, we investigated higher cognitive factors hypothesized to contribute to reading development, specifically, early bilingual language and reading exposure. The experiment was a classic lexical decision task that measured forced-choices for orthographic (pseudoword v. false font) and phonological pairs (pseudoword v. nonword). Children were trained beforehand. Data were time-locked and analyzed from 32 children across 4 groups (see Demographics): younger and older hearing monolinguals (H1, H2; English only) and younger and older deaf bilinguals (D1, D2; English and American Sign Language, ASL). Behavioral data were modeled with mixed-effects statistics in R. fNIRS brain imaging (cognition) were analyzed using the NIRS Brain AnalyzIR Toolbox in MATLAB.[8] Brain-behavior data were correlated in R using a priori regions of interest (left inferior frontal cortex, LIFC, and left posterior superior temporal gyrus, LpSTG. Eye tracking (visual attention) data were analyzed using gaze allocation ratios. Preliminary results revealed H2 were most accurate for orthographic (pseudoword v. false font) and phonological decisions (pseudoword v. nonword), followed by D2, then D1. H1 responded the least accurate for both types of decisions. Significant differences in response variables between ages (younger v. older), but not between groups (hearing v. deaf). Accuracy and reaction time correlated with brain activation in LIFC across all children. Brain activation in LIFC and LpSTG also correlated. D2 gazed at the correct words most for both types of decisions. D1 gazed at correct words more than H1 for orthographic decisions, with the opposite being true for phonological decisions. Children's reading develops similarly from ages 5 to 7 years, regardless if the children are hearing monolinguals (English) or deaf bimodal-bilinguals (English+ASL). ***Learning to read does not require sound.*** These findings also suggest neurocognitive advantages for sign language bilingualism in reading. Through novel brain+eye+behavior technology integration, new insight is revealed about the neuroplasticity of the human brain and the positive bootstrapping impact of visual sign phonology on reading development. This work has broad scientific and translational impact by identifying ***factors that may benefit all children*** in learning to read.

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