Multisensory audio-visual stimuli speed up reaction times in children with and without cerebral palsy.

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INTRODUCTION

Cerebral palsy (CP) is a set of motor and cognitive disorders that are attributed to non-progressive brain damage occurred during the development of the fetus, at birth or during infancy (Rosenbaum et al., 2007). In healthy adults and typically developing (TD) children, the sensory modality of stimuli (visual, auditory or both) influences Reaction Times so that multisensory stimuli (e.g., audio-visual) induce faster RTs than unisensory stimuli, thanks to a multisensory integration process (Brandwein et al. 2011; Shams & Seitz, 2008).

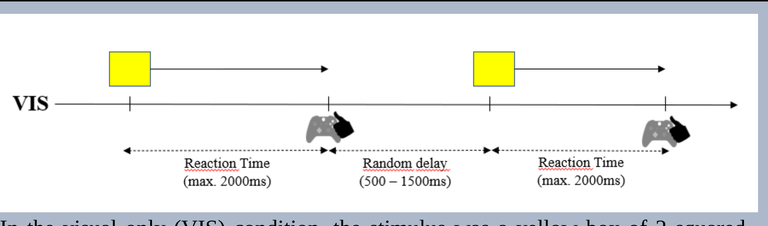
Do children with and without cerebral palsy benefit from multisensory audio-visual stimuli?

PROCEDURE

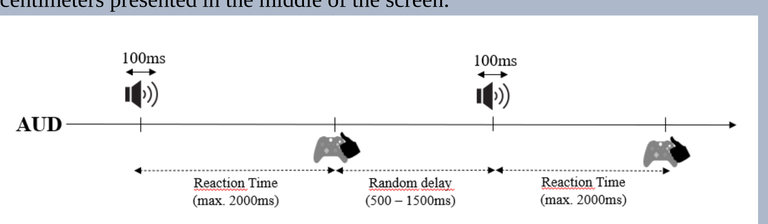
Participants were required to press a button with their dominant hand as fast as possible every time they saw a yellow box or they heard a beep. Once the button was pressed, the computer recorded the participant's reaction time and then moved to a new target after a response–stimulus interval varying between 500ms and 1500ms to avoid anticipation. Four counterbalanced conditions (VIS, AUD, CAV, IAV, see below) of 25 trials of maximum 2 seconds.

POPULATION

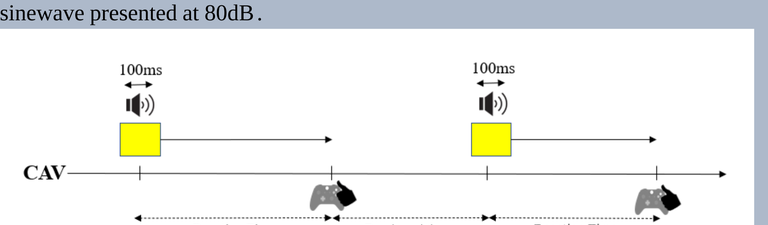
	Adults	CP children	TD children
Participants	23	16	20
Age (years or months)	24.72 ± 2,96	108.52 ± 24.93	105.80 ± 27.43
Laterality Quotient	80.89 ± 27.21	22.26 ± 78.91	71.05 ± 39.45
Sex-ratio (F/H)	11/12	6/10	8/12
GMFCS (I à IV)		2.31 ± 0.87	
MACS (I à IV)		1.81 ± 0.98	



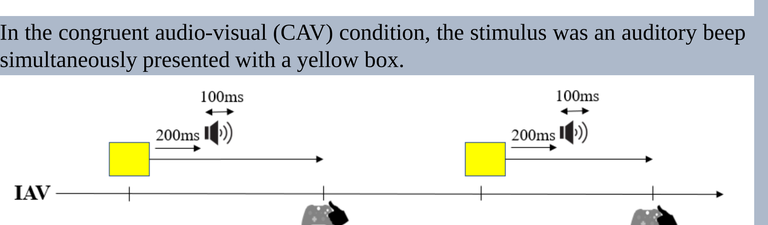
In the visual only (VIS) condition, the stimulus was a yellow box of 2 squared centimeters presented in the middle of the screen.



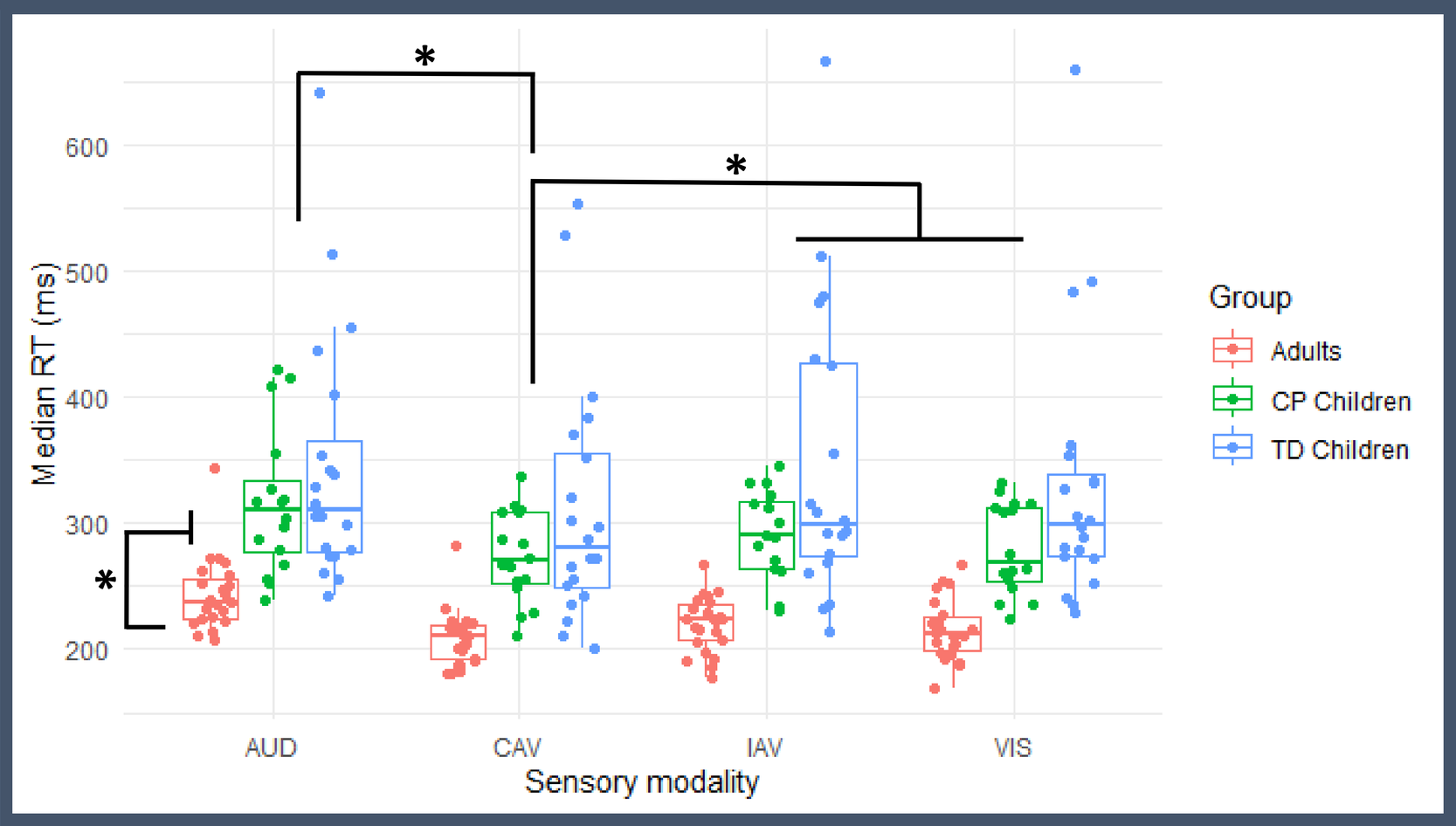
In the auditory only (AUD) condition, the stimulus was a 500Hz, 100ms sinewave presented at 80dB.



In the congruent audio-visual (CAV) condition, the stimulus was an auditory beep simultaneously presented with a yellow box.



In the incongruent audio-visual (IAV) condition, the auditory beep was presented 200ms after the visual stimulus.



Box-plot of median Reaction Time (RT) in milliseconds (ms) for every Group and every Condition.
AUD = Auditory only; CAV = Congruent Audio-Visual; IAV = Incongruent Audio-Visual; VIS = Visual only.
Horizontal lines = median, box = 25−75%, vertical lines = 5–95%.

RESULTS

→ ANOVA revealed a **Group effect** on RTs (F (2,56) = 23.54, $p < .001$, $\eta^2_p = .46$, $BF_{10} > 100$). Post-hoc revealed that **Adults were faster than both CP and TD children** ($p < .001$).

→ ANOVA revealed a **Condition effect** (F (3,168) = 19.58, $p < .001$, $\eta^2_p = .26$, $BF_{10} > 100$). Post-hoc revealed that **RTs were shorter in CAV than in all other conditions** (AUD: $p < .001$; VIS: $p = .001$; IAV: $p < .001$).

Our results suggest that the multisensory integration process is preserved in children with CP and could be used in motor rehabilitation protocols.

- Rosenbaum, P., Paneth, N., Leviton, A., Goldstein, M., Bax, M., Damiano, D., ... & Jacobsson, B. (2007). A report: the definition and classification of cerebral palsy April 2006. Dev Med Child Neurol Suppl, 109(suppl 109), 8-14.
- Brandwein, A. B., Foxe, J. J., Russo, N. N., Altschuler, T. S., Gomes, H., & Molholm, S. (2011). The development of audiovisual multisensory integration across childhood and early adolescence: a high-density electrical mapping study. Cerebral cortex, 21(5), 1042-1055.
- Shams, L., & Seitz, A. R. (2008). Benefits of multisensory learning. Trends in cognitive sciences, 12(11), 411-417.
- Oldfield, R. C. (1971). The assessment and analysis of handedness: the Edinburgh inventory. Neuropsychologia, 9(1), 97-113.