Visual Inspection Time and Graphomotor Processing Speed in Children With Cerebral Palsy

J. KAUFMAN1, M. VAN TUBBERGEN1, J. DONDERS2, S. ASBELL2 & S. WARSCHAUZSKY3

E-Mail: jaqk@umich.edu

1Department of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, Michigan.
2Department of Psychology, Mary Free Bed Hospital, Grand Rapids, Michigan.

Introduction

- Processing Speed (PS) is associated with development of critical cognitive functions including working memory and fluid intelligence, and is sensitive to brain dysfunction, medication effects, and aging.
- There is evidence to suggest that children with cerebral palsy are at risk for slowed PS.
- Instruments often used in studies of children with CP have had significant motor response demands (Christ et al., 2003). Traditional PS measures such as Weschler Coding and Digit Symbol tests have significant motor demands and are of questionable validity as measures of cognitive PS for many children with CP.
- Inspection Time (IT) has been studied extensively as a measure of general speed of processing. Recent work suggests that while IT is a measure of general speed of processing, it more specifically measures speed of visualization as one component of PS (O’Connor & Burns, 2003).
- As a procedure that largely by-passes the speeded motor response demands of traditional PS instruments, IT tasks have tremendous potential as accessible measures of PS for individuals who have physical impairments.
- This study evaluated IT in children with diagnoses of CP relative to typically developing peers, and examines relationships of IT performance with performance in traditional graphomotor measures of PS (WISC-III).

Participants

- Demographic and developmental characteristics by Group
  - Variable | CP (n=69) | TD (n=38)
  - Age (years) | 11.5 (2.5) | 10.9 (2.6)
  - Gender (% male) | 60.5% | 49.4%
  - PPVT-III | 102.1 (16.9) | 108.1 (16.1)
  - Gestation (weeks) | 32.8 (5.9)* | 37.9 (3.2)
  - Birth Weight (lbs) | 4.6 (2.5)* | 7.0 (1.7)
  - History of seizure | 17 %* | 1.0 %

Analyses and Results

- Participants were shown a fixation point for 3000ms (A) with brightening (B) lasting 1500ms to assist with orientation to impending stimulus presentation. A clear screen (C) was followed by the target stimulus presentation with varying duration (D). A visual stimulus mask (E) was used to prevent visual rehearsal of the target (on-screen mask duration = 1000ms – (DurationTarget + 25ms)).
- In the standard task condition (upper example), mask stimuli are followed by a blank screen (F) which remains for duration of participant response using keyboard arrow keys to the question, “which side of the figure had the longer leg?”
- In the adapted task condition (lower figure) participants were shown both a correct target and an inverse stimulus which served as a lure. A selection box alternated between stimulus choices at a scan rate determined by the participant to be a comfortable pace (i.e. allowed participant to initiate and complete motor response while preferred stimulus choice was selected). Response selection in the adapted condition (Gadapted) was by Big Buddy pressure switch.
- IT was estimated using a stepwise technique (Wetherell and Levitt) to identify the threshold presentation time required to make an accurate response. Following 3 accurate responses, presentation rate was reduced by 17ms, and increased by 17ms after a single error. Final inspection time was calculated as the mean of the last eight reversals.

Findings demonstrate slower performance for both processing speed and inspection time measures for children with CP relative to their typically developing peers.
- Slowed processing speed observed in those with CP does not appear to be secondary exclusively to slowed motoric functioning, as a measure of processing speed which is relatively independent of speeded responding yields similar group differences.
- The inspection time measures administered correlate differently with traditional graphomotor processing speed measures for those who are typically developing relative to those with diagnoses of CP. This appears to be due in part to a floor effect for the inspection time measures for the typically developing participants.
- Removal of extreme CP group participants’ data from analyses (3 participants) resulted in expected correlations between both IT measures and traditional processing speed measures for those with CP diagnoses; this emerging finding appeared to be related to greater variance for this group.
- For individuals with diagnoses of CP who have extreme scores, it appears likely that discrepancies in performance are indicative of these measures evaluating differing constructs.
- The current study evaluates visual inspection time tasks which significantly reduce speeded motor response demands hold considerable potential for use as measures of cognitive processing speed in populations for whom speech and motor demands preclude valid participation in testing of this construct.
- Future directions include design modifications aimed at reduction of floor/ceiling effects and ensuring adequate gradations of difficulty.

Conclusions

- All children in the CP group demonstrated the ability to provide a reliable dichotomous choice response.
- Children were recruited in accordance with IRP requirements from the community and associated medical appointments at two Michigan health care facilities.
- Findings demonstrate slower performance for both processing speed and inspection time measures for children with CP relative to their typically developing peers.
- Slowed processing speed observed in those with CP does not appear to be secondary exclusively to slowed motoric functioning, as a measure of processing speed which is relatively independent of speeded responding yields similar group differences.
- The inspection time measures administered correlate differently with traditional graphomotor processing speed measures for those who are typically developing relative to those with diagnoses of CP. This appears to be due in part to a floor effect for the inspection time measures for the typically developing participants.
- Removal of extreme CP group participants’ data from analyses (3 participants) resulted in expected correlations between both IT measures and traditional processing speed measures for those with CP diagnoses; this emerging finding appeared to be related to greater variance for this group.
- For individuals with diagnoses of CP who have extreme scores, it appears likely that discrepancies in performance are indicative of these measures evaluating differing constructs.
- The current study evaluates visual inspection time tasks which significantly reduce speeded motor response demands hold considerable potential for use as measures of cognitive processing speed in populations for whom speech and motor demands preclude valid participation in testing of this construct.
- Future directions include design modifications aimed at reduction of floor/ceiling effects and ensuring adequate gradations of difficulty.

Acknowledgments to Donna Omichinski, Lynn Driver, Nicole Miller, and Danielle Sandella. Supported by NIH R21 HD052592 and DOED NIDRR H113G070044