Biological Motion Perception in Children Born Very Prematurely

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ABSTRACT

Biological motion perception involves several distinct processes.[1] Deficits in one of these (detection of structure-from-motion) have been documented in preterm children.[2,3] Here, we show that 8-11 year old children born prematurely at very low birthweight (< 1500 gm) are impaired, relative to full term controls, in the extraction of local motion cues (p = .039), structure-from-motion detection (p = .067), and action recognition (p = .026). In addition, unlike controls, they show no age-related improvement in style recognition (Age X Group, p = .017). These results could inform the development of screening, diagnostic, and intervention tools.

INTRODUCTION

Troje[1,4] has suggested that biological motion processing involves several distinct processes, including extraction of local motion cues, extraction of global structure-from-motion cues, categorization of actions, and retrieval of specific information about agent/action.

To date, only limited research has been conducted into the effects of prematurity and associated complications on the processing of biological motion stimuli, and this work has focused on the operation of the structure-from-motion mechanism. We have shown[2] that very preterm children (< 32 weeks gestation) show lower sensitivity to global biological motion than full-term controls. Pavlova[3] suggests that the extent of this impairment correlates with the extent of damage to the parieto-occipital white matter.

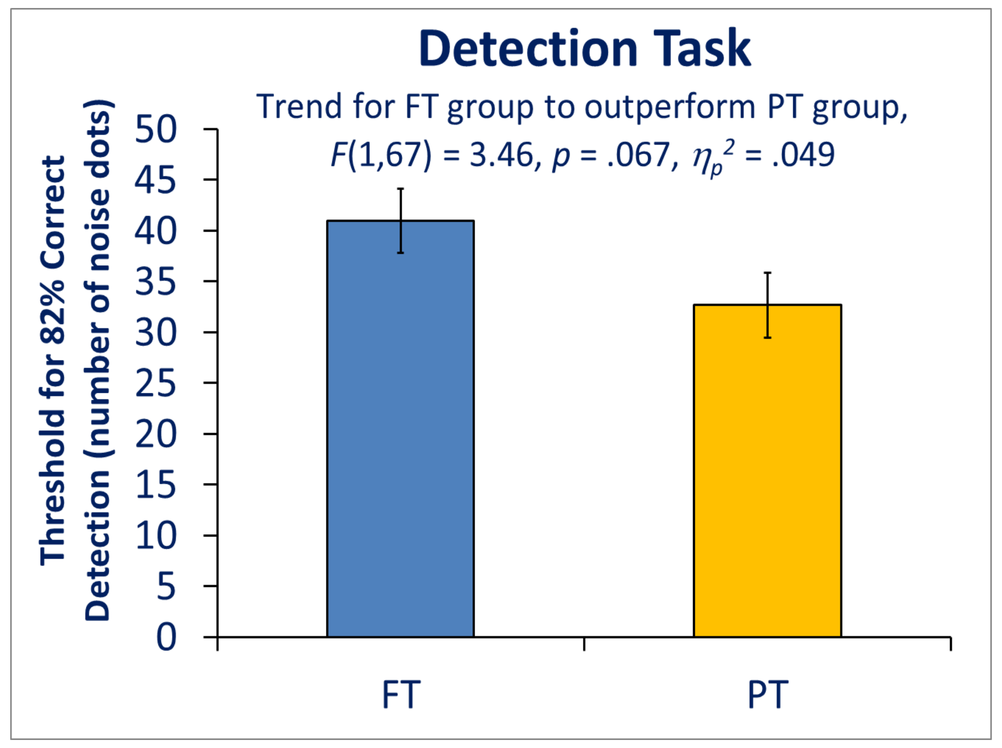
The goal of the present research was to examine the impact of prematurity on the development of multiple aspects of biological motion processing.

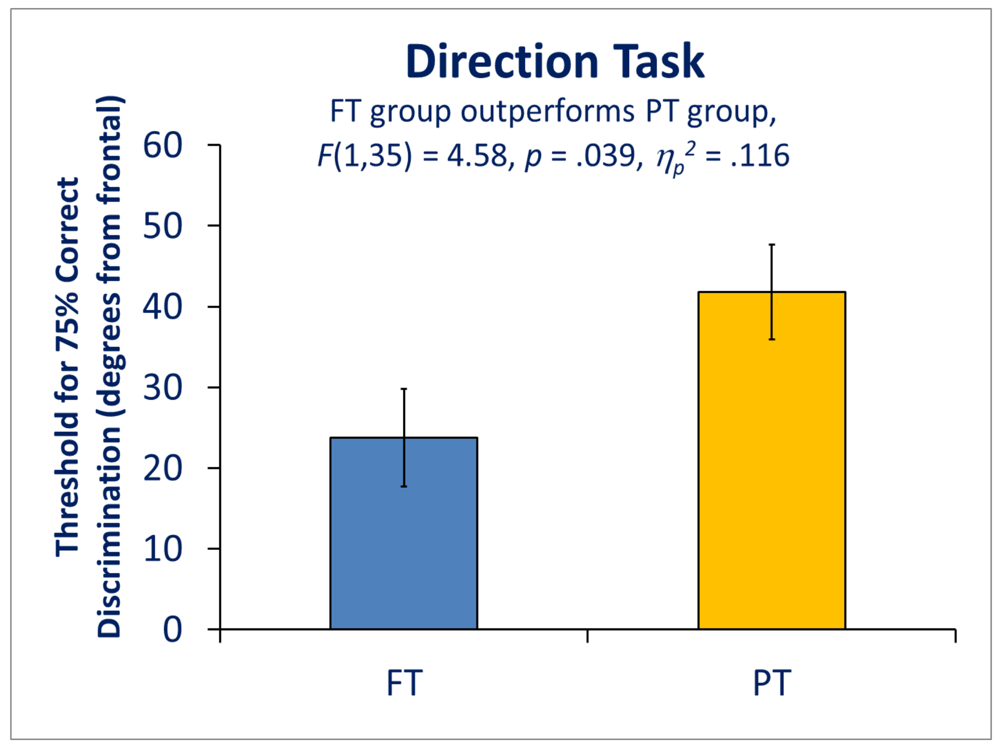
PARTICIPANTS

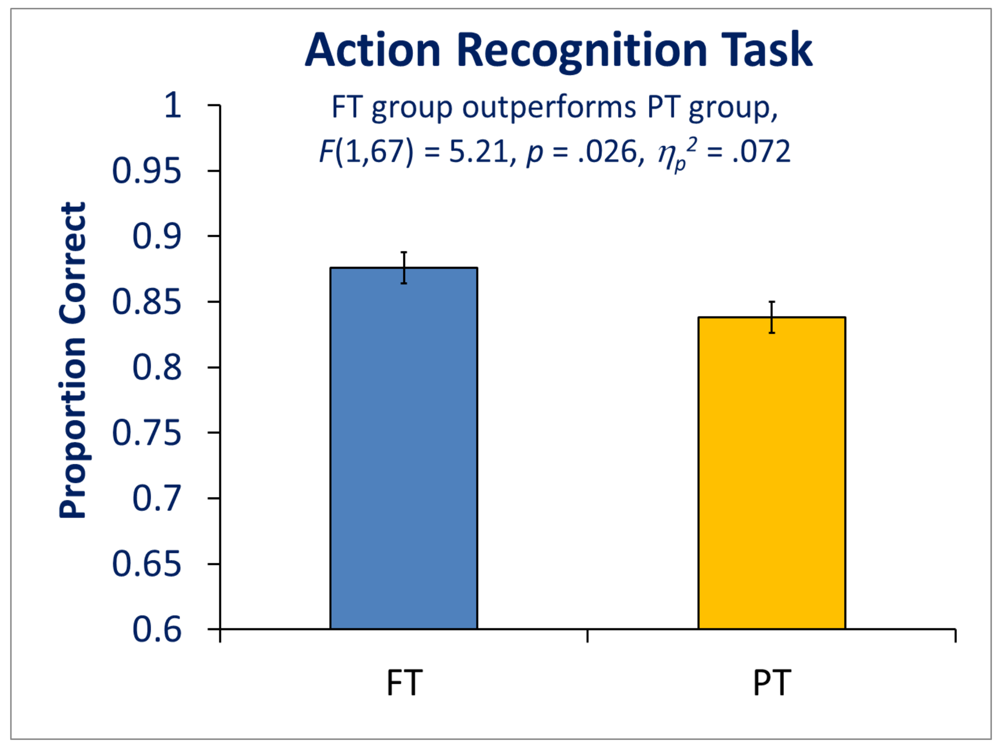
TABLE 1	**Full-Term (FT)** (n = 35)	**Preterm (PT)** (n = 34)
Gestational age (weeks)	Inclusion criteria specified a range of 38-42	M = 28 (SD 2)
Birthweight (g)	M = 3639 (SD 459)	M = 1081 (SD 247)
FT and PT samples were comparable in terms of the variables listed below (independent sample t-tests and X^2 tests, p > .05 in all cases)		
Handedness	5 L: 30 R	4 L: 30 R
Age in months	M = 123 (SD 15)	M = 120 (SD 15)
Gender Distribution	17 F: 18M	18F: 16M
Cancellation task (s)[a]	M = 37.1 (SD 16.6)	M = 37.3 (SD 14.7)
PPVT4 (standard score)[b]	M = 112.6 (SD 11.1)	M = 108.4 (SD 12.3)
Parental education (mode)	Partial to completed college/ university or specialized training	Completed partial college/ university or specialized training
Family income(mode)	Over CAD $75,000	Over CAD $75,000

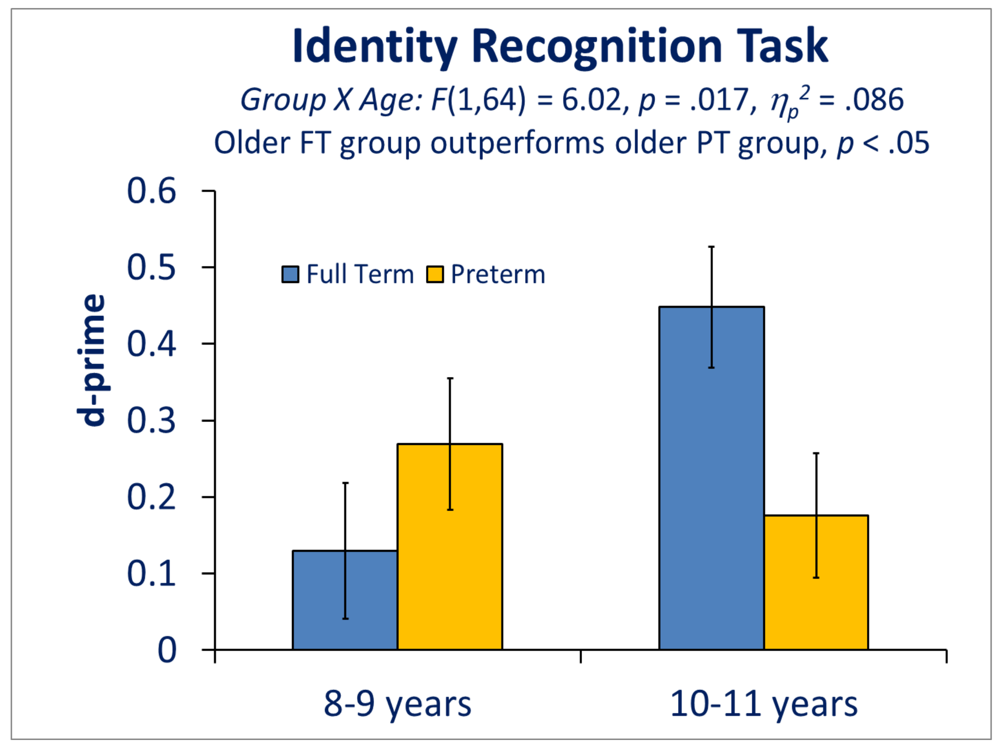
[a] Cancellation task used to estimate processing speed
[b] Age-corrected standard scores on the PPVT-4 used to estimate verbal intelligence

References: (1) Troje (2008) Oxford series in visual cognition. (pp. 308-334). New York, NY, US: Oxford University Press. (2) Taylor et al., (2009) *Neuropsychologia, 47*, 2766–2778. (3) Pavlova *et al*. (2003) *Brain, 126, 692-701.* (4) Troje & Westhoff, (2006). *Current Biology, 16*, 821-824.

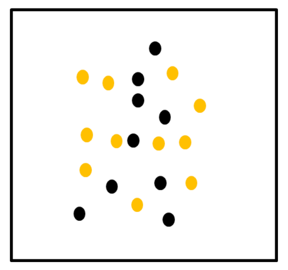




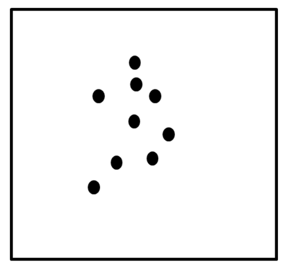




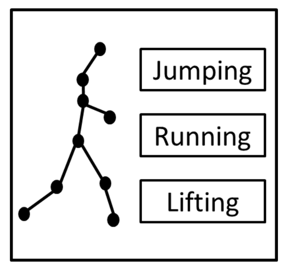
METHODS



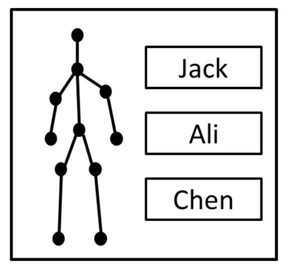
Detection. Each trial involved two sequentially-presented displays depicting spatially-scrambled point-light walkers; in one of these, a coherent walker was embedded. The child decided which display contained the walker; 82% correct detection thresholds were computed. To perform well, participants must be sensitive to global motion cues to body structure.



Direction. On each trial, the child viewed a spatially-scrambled point-light walker. Facing direction varied from 0º (frontal view) to ±90º (sagittal view). The threshold (absolute value of facing direction) for 75% correct direction discrimination was computed. To perform well, participants must be sensitive to the local motion cues signaling facing direction.



Action. In this task, stick figures displaying 10 different actions (i.e. jumping, running, lifting) were presented one at a time. The child was asked to choose the label that best described each action, from a list of 10 descriptors. Accuracy was measured.



Identity. This task, which requires discrimination of individuals' movement styles, involved three stages. In the *memorization stage*, participants were familiarized with the 'walks' associated with three individuals. In the *naming stage*, they practiced naming each walker, with corrective feedback. In the *old-new stage*, they indicated if the walker they were currently viewing was from the original set or not; d-prime scores were computed for these judgments.

RESULTS

ANOVAs were used to compare the performance of FT and PT samples on each task. Because we were unable to measure thresholds for almost half of the children in each sample on the Direction task, this analysis was limited to those children who were able to do the task (note: these subgroups of PT and FT children were comparable on matching variables in Table 1.)

PT children had difficulties on all four tasks. Thus, they had slightly more difficulty extracting global structure from noise (trend in Detection Task), needed stronger directional cues to assess facing direction using local motion (Direction Task), and were less accurate at action identification (Action Recognition Task) when compared to FT children. Although, overall, the groups did not differ in performance on the Identity Task, age was significantly correlated with d-prime scores on this task in FT children (r_{35} = .56, p < .001) but not in PT children (r_{34} = .024, p = .89). Moreover, a supplementary analysis showed that group differences (favouring FT children) were evident in the subgroup of children aged 10-11 years old. These results suggest that PT children do not show typical age-related improvement in their ability to discern individual identity from unique movement patterns. (See central figures.)

No significant correlations were seen between scores on any of the 4 tasks, in either sample.

CONCLUSIONS

Very preterm birth is associated with impairments in multiple aspects of biological motion perception. These findings extend earlier work showing problems with and a range of motion-processing tasks in this population.[2,5,6] These impairments may be linked to injury to and/or atypical development of the preterm brain, and may contribute to difficulties in a range of higher-order skills.

ACKNOWLEDGMENTS

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