Attention capacities of preterm and term born toddlers: A multi-method approach

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ABSTRACT

Objective: Many preterm children show difficulties in attention at (pre)school age. The development of attention capacities of preterm and term toddlers was compared using a longitudinal and multi-method approach at 12, 18 and 24 months.
Method: Attention was measured for 123 preterm (32–36 weeks gestation) and 101 term born children, using eye tracking (18 months), observations during mother–child interaction (18 months), and mother-reports (12, 18, and 24 months).
Results: Preterm toddlers had lower scores than term children on the eye-tracking measures of orienting and alerting. No group differences were found with observations, mother-reports, and the eye-tracking measure of executive attention. More preterm than term children had suboptimal scores on measures of the alerting system at 18 months, possibly indicating difficulties in attention development.
Conclusion: Preterm children showed an increased risk for suboptimal functioning in alerting attention capacities, as early as at a toddler age.

1. Introduction

Around 9% of all children worldwide are born preterm after a gestational age of between 32 weeks and 36 weeks and 6 days [1]. These children are at increased risk for a wide range of cognitive, school and behavior problems [2], which include attention problems. When a child is born preterm, the brain is still immature. Therefore, brain development may have been affected in the neonatal period, which might result in attention problems or other difficulties in functioning [3]. Attention problems were reported in preterm children at preschool [4, 5] and school age [6,7]. Furthermore, 6 to 19 year old preterm children were found to have an increased risk for Attention Deficit Hyperactivity Disorder [8].

The development of attention capacities of preterm children needs to be studied, since these capacities are a crucial part of everyday life, and attention problems might underlie other difficulties, such as cognitive problems [9]. Few studies as yet studied attention capacities in preterm children at toddler age. Studies at this age are important, because it is in this critical developmental phase that children gain increasingly more control over their attention capacities [10]. Furthermore, if differences between preterm and term born children are already noticeable at this age, early detection of difficulties in attention development might be facilitated. Such information could help designing interventions to improve these capacities and reduce problems in daily functioning.

Attention can be defined as a multi-dimensional construct including three attention systems: orienting, alerting, and executive attention [11]. Orienting represents the ability to engage, disengage, and shift attention. Alerting is the ability to achieve and maintain a state of alertness (i.e. sustained attention). Executive attention is a more self-generated form of attention, which is goal-directed and planned [11, 12]. Research focusing on the three attention systems, as opposed to more general attention problems, could give more insight into the specific problems that preterm children might have, which would enable the development of intervention methods targeting these specific skills. Concerning very preterm children, born before 32 weeks' pregnancy, a few studies were done on the functioning of attention systems and these showed mixed results. There are indications that preterm children temporarily have better orienting skills (i.e. faster disengagement) during the first months of life than term born peers, but that this benefit disappeared after 3 to 4 months and the groups were found to perform equal [13–15]. At later age, both Snyder et al. [16] and Pizzo et al. [17] found that the preterm children performed slower than term children on all three attention systems at 4–6.5 years of age. In contrast, De Kievit et al. [9] found no group differences on the three attention systems at 7–8 years of age. Although it

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has been found that preterm children showed more attention problems [4,5], no studies were found as yet that investigated the functioning of the *separate attention systems* in detail in these children at toddler age.

Different methods may be used to measure attention, such as computerized tasks, observations and parent-reports. Previous studies with toddlers mainly used observations during play settings and/or questionnaires filled out by parents or caregivers in order to measure attention [18,19]. A few studies investigated the relation between different methods, multiple informants and varying contexts, to measure attention [18,20–22]. When mothers reported better sustained attention capacities at 13.5 months of age, more sustained attention was observed during a free play session in a lab setting [21]. Gaertner et al. [18] also found a (small) positive correlation between mother-reported and observed sustained attention at 30 months of age: children who had better sustained attention capacities according to their mother, were observed to play by themselves for a longer period of time. However, in the same study no relations were found between the assessments of sustained attention by different instruments, in different contexts or at different ages [18]. Wass [22] found no relation between peak look duration during computerized tasks, which can be considered a measure of the orienting system, and naturalistic/play tasks at 11 months of age. Davis et al. [20] also found no relation between maternal report and attention measured with computerized tasks at 4–5 years of age.

It might be the case that different methods focus on different systems of attention. It is not clear yet what instrument, or which combination of measurements, is the best method to obtain a good impression of the attention capacities of toddlers. Therefore, in the current study, attention capacities were measured repeatedly and by different types of instruments and informants. Recently, we have concluded that it is feasible to measure functioning of all three attention systems (i.e. orienting, alerting, and executive attention) in toddlers with a test battery of four computerized eye tracking tasks; the Utrecht Tasks of Attention in Toddlers Using Eye tracking (UTATE, [23]). Aside from the UTATE, video-taped observations during mother–toddler interaction in lab situations were used, as well as repeated mother-reports. The relationships between these different methods will be explored.

In the current study, attention capacities of preterm children born with a gestational age between 32 weeks and 36 weeks and 6 days, are compared to attention capacities of term born peers at toddler age using a multi-method approach with measurements at different time-points. Based on previous studies at (pre)school age [4–7], preterm children are expected to show suboptimal functioning, compared to their term born peers at toddler age, on the different indicators of attention capacities.

2. Method

2.1. Participants

Parents of preterm children born at a gestational age of 32 weeks and 36 weeks and 6 days in eight hospitals in and around Utrecht in the Netherlands were invited by letter by their pediatrician to participate in the study when their child was 10 months old. For the control group, parents of term born children with a gestational age of ≥37 weeks, born in four hospitals in and around Utrecht, were invited by letter by their midwives when their child was 10 months old to participate in the study. These children were all born between March 2010 and April 2011. For both groups, exclusion criteria were dysmaturity (i.e. birth weight below 10th percentile according to Dutch reference curves from Stichting Perinatale Registratie Nederland [24]), multiple births, admission to a tertiary Neonatal Intensive Care Unit, severe congenital malformations, antenatal alcohol or drug abuse by the mother, and chronic antenatal use of psychiatric drugs by the mother.

The medical ethical committee of the Utrecht Medical Center approved this study. Informed consent was given by the parents. The children received a small gift after the visit and the parents received refund of travel expenses.

2.2. Procedure

This study is part of an ongoing longitudinal project on the development of preterm children, the STAP Project (i.e. Study on Attention of Preterm children). When the children were 12, 18, and 24 months of age, corrected for prematurity, the mothers were asked to answer questionnaires concerning the development and behavior of their children and their parenting behavior. When the children were 18 months of corrected age, they visited our lab for an evaluation of attention capacities by means of an eye tracking procedure and an observation of mother–child interaction. The visits were planned in such a way that these would not interfere with the children's sleeping schedules. The eye tracking procedure was described in detail in BLINDED [25]. After the eye tracking procedure, the mothers were asked to play with their child for 15 min: 5 min of free play and 10 min of structured play (i.e. reading a book and making a puzzle, both for 5 min). The interaction was videotaped and coded afterwards.

2.3. Instruments

Attention capacities were measured by eye tracking techniques, observations, and questionnaires.

2.4. Eye tracking measures

The Utrecht Tasks of Attention in Toddlers using Eye tracking (UTATE) was used at 18 months of age to measure attention capacities, using four tasks: 1) a disengagement task, 2) a face task, 3) an alerting task, and 4) a delayed response task [25]. In the *disengagement task*, a visual stimulus was first presented at the center of the screen, and after 2 s a second stimulus appeared at the left or the right side of the central stimulus, while the central stimulus stayed on the screen. This task consisted of 20 trials. In the *face task*, two identical pictures of children's faces were shown, and after 8.5 s one of the pictures changed into a new picture and stayed on the screen together with the previously shown picture for 8 s. The face task consisted of eight trials. In the *alerting task*, a visual stimulus was presented on the screen, preceded in half of the trials by a signaling sound. The alerting task consisted of 32 trials. In the *delayed response task*, a dog was hiding in one of two visible doghouses and after a certain interval (i.e. varying from 0–10s) the child was asked to search for the dog. This task consisted of 18 trials in which the interval increased from 0–10 s with steps of 2 s after three consecutive trials. The tasks are described in more detail elsewhere [25]. For the total group of children, the split half reliability of the UTATE was found to be good (r = .71–.95) for nine of thirteen variables. Moreover, evidence for construct validity was found as a Confirmatory Factor Analysis showed that the different aspects coded during the four tasks (see Table 1) could be reduced to three latent constructs: orienting, alerting and executive attention [23].

The amount of root mean square (RMS) noise of the eye tracking signals is a measure of data quality. Comparison of the RMS noise between the preterm and term born group showed no significant difference, indicating that the quality of the eye tracking data was equal across the two groups, Wilk's $\Lambda = .93$, $F_{8,190} = 1.88$, $p = .07$.

A measurement invariance test on the factor structure that was confirmed in a sample of term born children [23], following the procedure described by Van de Schoot et al. [26], showed scalar invariance. This indicated that the same factor model applied to the preterm sample, and enabled a comparison of the mean scores on the three latent constructs across the two groups. Hence, scores on the latent