Language Status in Children with Birth Asphyxia: A Follow Up Study

(Brain and Language)

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***Abstract*—Development of the brain is essential to facilitate language acquisition. Any form of injury and malfunctioning of the brain can inhibit language acquisition in children and in the case of adult can lead to dysfunction of language (Lenneberg, 1967 as cited in Lust, 2006). Birth asphyxia is one of the major high risk factor that can interfere in language acquisition (Jansson-Verkasalo, 2004) and causes delay in speech and language development (D'Souza, Nolan, McCartney & Taylor, 1981). This follow up study (2011) is an extension of a pilot study conducted by Shanthini et al. (2009) which was done to check if there is any deviance in the language status of the children with birth asphyxia in relation to their APGAR score, time at which the APGAR score reached 8 and their cognition pertaining to language as the subject's age increases and to compare the findings to that of the typically developing children with respect to their gender by administering picture description and general conversation tasks targeting on morpho-syntactic structures in Tamil.**

Keywords: Birth Asphyxia; Language status; APGAR score; Time at which APGAR score reached 8; Cognition pertaining to Language.

I. Introduction

Language is the mode by which human communicates ones thoughts or intentions to an individual or to a group of people (Owens, 2001). Language acquisition is the process of acquiring the knowledge of language, which according to psycholinguists comprises finite set of rules (Chomsky, 1965 as cited in Shulman & Capone, 2010). Almost every child language researchers have established that all normal children acquire language to which they are exposed to, and conversely children who are not normal in one sense or the other find it hard to acquire language (Wiig & Secord, 1982; Mogford & Bishop, 1988).

They have identified several contributing factors towards language acquisition such as presence of functionally normal cortical structures, normal cognitive functioning, normal sensory input system, normal motor output mechanism, adequate linguistic environment and healthy child during prenatal, perinatal and postnatal period. Language acquisition can be affected when any one of the pre-requisites for normal speech and language development are affected or inadequate.

Development of the brain is essential to facilitate language acquisition. Any form of injury and malfunctioning of the brain can inhibit language acquisition in children and in case of adult can lead to dysfunction of language (Lenneberg, 1967 as cited in Lust, 2006).

As language representation and organization is a cerebral process, pathological conditions in it would lead to severe cognitive dysfunction. However, the cognitive deficit in an adult would have quite different consequences when compared to children (Anderson, Smith, Leventer, Coleman, Anderson, Williams, Greenham & Jacobs, 2009).

In cases of focal left hemisphere insult or complete removal of left hemisphere, children show a better recovery pattern than adults (Heywood & Canavan, 1987; Taylor & Alden, 1997). In contrast, children sustaining generalized cerebral insult such as 'Traumatic Brain Injury' (TBI) or early 'Cerebral Vascular Accident' (CVA) display slower recovery and poorer outcome in intellectual and academic achievements than adults with similar insults (Taylor, Yeates, Wade, Drotar, Stancin & Minich, 2002; Anderson, Catroppa, Morse, Haritou & Rosenfeld, 2005; Ballantyne, Spilkin, Hesselink & Trauner, 2008). It is found that brain insult prior to the age of 2 years leads to poor cognitive outcome but when the insult occurs at the later childhood, there will have lesser impact in cognition (Anderson et al., 2005). Thus it is evident that normal functioning of the brain is critical for language acquisition.

Generally high risk infants are vulnerable to delay in language acquisition due to injury or malfunctioning of the brain (Jansson-Verkasalo, 2004). Birth asphyxia is one of the major high risk factor which has been reported to cause brain insult at the time of birth (Majeed, Menon, Shaikh, Majeed & Rajar, 2007; Haider & Bhutta, 2006); (Windle, 1969) which causes delay in speech and language development (D'Souza, Nolan, McCartney & Taylor, 1981).

Birth asphyxia, also called Asphyxia Neonatorum, is defined as the failure to start regular respiration within a minute of birth. It is a condition in which extreme decrease in the concentration of oxygen in the body accompanied by an increase in the concentration of carbon dioxide that leads to loss of consciousness or death (Cheung & Robertson, 2000; Donn, Sinha & Chiswich, 2002). When this condition is prolonged or the impact of the condition is adverse it leads to injury or malfunctioning of the brain. This will inhibit the aerobic metabolism in the internal structures where the oxygen supply is reduced (Park, Sanders & Maltepe, 2010).

Figure 1 below shows the pathophysiology of birth asphyxia. When this condition occurs it will trigger any one of the two reactions namely ionic shift and depolarization or energy failure and acidosis simultaneously. Once any one of the reaction takes place it will lead to other two reactions interchangeably namely increase in the release of neurotransmitter and there will be a reduction in the uptake of neurotransmitter simultaneously and phospholipid degradation followed by increase in the free fatty acids and free radical

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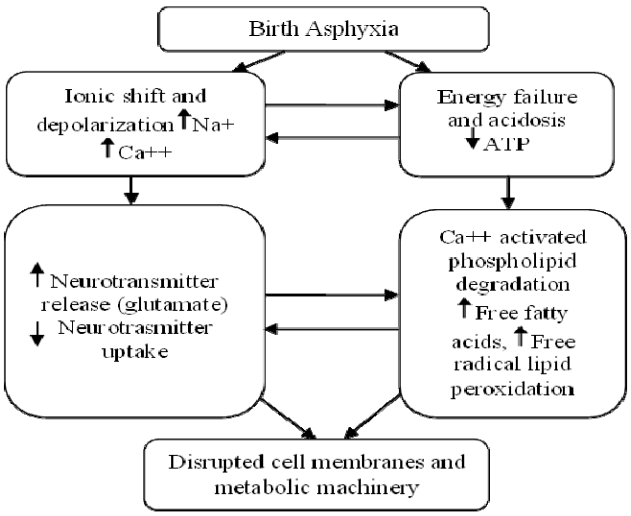
lipid peroxidation. All these change in the cellular mechanism results in disrupted cell membranes and metabolic machinery.

Figure 1



The pathophysiology of birth asphyxia

Hence children who had birth asphyxia for a prolonged period is most likely to exhibit neurological impairment, motor impairment, cognitive impairment, language deficits, speech and language disorders, sensory impairments or other consequences, manifestations or associated problems depending on the site of oxygen deprivation.

However the incidence of birth asphyxia varies across different countries, states, urban and rural areas. Apart from this biological factors such as antenatal care which include prenatal (poor nutritional status and anaemia), perinatal, post-natal care and others (Majeed et al, 2007) and environmental factor such as socio- economic status plays a vital role in the incidence of birth asphyxia (Straube, Voigt, Jorch, Hailler, Briese, & Borchardt, 2010). The incidence of asphyxia in Britain in 1960's and in the United States in 1970's was 1.2 to 5% of birth asphyxia among which 0.4% to 1.6% had severe form of asphyxia (Addy, 1982). Of 25 million infants born in India, the incidence of asphyxia was found to be 3 to 5% (Ghai, Gupta, & Paul, 2004).

There are many causes of birth asphyxia. The most common cause are prenatal hypoxia, fetal distress, umbilical cord compression, knotting of umbilical cord around the head, neck or body of the faetus, aspiration of amniotic fluid, meconium stained and others (Majeed et al, 2007; Simon & Morley, 2005). The clinical signs of birth asphyxia are based upon the colour, heart rate, reflex irritability, muscle tone and respiratory effort. The symptoms of asphyxia are cyanosis, bradycardia, hypotonia, poor response to stimulation and reduced respiratory effort.

Diagnosis of birth asphyxia can be objectively made by using the APGAR score, a recording of physical health of the newborn, determined after the examination of the appearance, pulse rate, grimace, activity and respiration (Apgar, 1953). APGAR score is obtained at the 1st, 5th, 10th, 15th and 20th minute of birth. However the APGAR score of the 1st, 5th and 10th minute is generally taken to check whether there is any neurological impairment. Occasionally children with birth asphyxia gets an APGAR score of 8 at the 2nd minute of birth itself and in those cases a mention of that time will be noted in their discharge summary (Khreisat & Habahbeh, 2005).

The scoring pattern of calculating the APGAR score depends on the symptoms and associated problems of each signs. The independent score is given based on the severity of the symptoms and associated problems manifested for each signs exhibited by the baby at the point of birth. The APGAR scoring system chart is illustrated in the table 1.

Table 1

APGAR five components	SIGNS	SYMPTOMS AND ASSOCIATED PROBLEMS Score =0	Score =1	Score =2	TOTAL SCORE ACROSS TIME IN MINUTES 1	5	10	15	20
Appearance	Colour	Blue or Pale	Acro-cyanotic	Totally Pink					
Pulse	Heart Rate	Absent	<100 Beats/ Minute	>100 Beats/ Minute					
Grimace	Reflex Irritability	No Response	Grimace	Cry or active Withdrawel					
Activity	Muscle Tone	Limp	Some flexion	Active motion					
Respiration	Respiratory Effort	Absent	Weak Cry	Good crying					

APGAR score of 8 at the **2nd min** of birth: …… (If applicable)

The APGAR scoring system chart

Table 2 below indicates the scoring pattern of APGAR score which is done by adding the corresponding score of each sign in the APGAR score sheet. Since there are 5 clinical signs, the total score will be out of 10.

Table 2

Symptoms and associated problems	Score
Normal symptoms	2
Slightly deviant	1
Deviant	0

The scoring pattern in calculating the APGAR score

Table 3 below indicates the severity of birth asphyxia

Table 3

APGAR score	Severity
8 to 10	Normal
5 to 7	Mild
3 to 4	Moderate
0 to 2	Severe

The severity scale of birth asphyxia

Birth asphyxia leads to various consequences depending on where is the extent of oxygen deprivation, exact site of lesion, APGAR score at the time of birth and severity of birth asphyxia. The consequences of birth asphyxia are language impairment such as "Delayed Speech and Language Development" (D'Souza et al, 1981) and "Specific Language Impairment" (Stanton-Chapman, Chapman, Bainbridge & Scott, 2002), neurological impairment such as "Learning Disability" (Bhate & Wilkinson, 2006), "Autism Spectrum Disorders" (Simon et al, 2005), "Attention Deficit Hyperactive Disorder" (Gustafsson & Kallen, 2010) and "Seizural Disorder" (Airede, 1991), Neuromotor Speech Disorder such as "Cerebral Palsy" (Simon et al, 2005), fluency disorder such as "Stuttering" (Somefuna, Lesib, Danfulania & Olusanyac, 2005), sensory impairment such as "Hearing Impairment" (Ohl, Czajka, Chobaut & Tavernier, 2009) and "Visual Impairment" (Ronald, Jan, Hill & Wong, 1986), cognitive impairment such as "Mental Retardation" (Simon et al, 2005), mortality (Jerneck & Herbst, 2001) and other complication either after birth or in the later stages of their lifetime. These manifestations can occur in isolation or in combination.

Children with birth asphyxia are prone to have associated problems (Avery & Taeusch, 1984). This high risk factor, "Birth asphyxia" can occur in isolation or in combination with other associated high risk factors such as low birth weight, preterm, hyperbilirubinemia, and others.

II. REVIEW OF LITERATURE

Research relating Birth Asphyxia to Neonatal Encephalopathy, Motor and Cognitive Impairment

Gonzalez and Miller (2006) found that children who survived from neonatal encephalopathy following perinatal asphyxia exhibited cognitive impairment. However, those who have survived from severe neonatal encephalopathy exhibited both cognitive and motor impairment.

Research relating Birth Asphyxia to Low APGAR Score, and Neurological Impairment (Cerebral Palsy) and Associated High Risk Factor (Low Birth Weight)

Paneth (2010) stated that children who had normal weight and had a low APGAR score of 4 for a prolonged period of time had cerebral palsy. However children who had low APGAR score and with an associated problem of low birth weight, cerebral palsy was less predictable because the presence or absence of cerebral palsy cannot be attributed directly to the low APGAR score alone. However the time at which the APGAR score reached 8 even if it brief or prolonged, whether APGAR score had improved, reduced or remain constant with respect to time and the severity of the other associated problem should be taken into account.

Research relating Birth Asphyxia to Cognitive and Behavioural Impairment

Anderson et al. (2009) found that children who had early brain insult before age 2 years exhibited global and significant cognitive deficits whereas children who had early brain insult after age 2 functioned closer to normal expectations. Linear correlation was noticed between the age of insult and the outcome. On the other hand when the behavioural domains were assessed, it was seen that children with late early brain insult from 7 to 9 years performed worse than those with early brain insult from 3 to 6 years. This concludes that, not all functions share the same pattern of vulnerability with respect to age at insult.

Research relating Birth Asphyxia to Neonatal Encephalopathy, Cognitive Impairment, Academic Performance, Neuropsychological Functioning and Behavioural Impairment

Handel, Swaab, Vries and Jongmans (2007) found that children with relatively mild degree of encephalopathy due to birth asphyxia performed relatively better in the 4 domains tested (cognition, academic, neuropsychological functioning and behaviour) when compared to those with severe encephalopathy. However there was varying outcomes in those who had moderate neonatal encephalopathy.

Research relating Risk Factors Birth Asphyxia and Early Identification

Majeed et al. (2007) found the risk factors of birth asphyxia in neonates were increased or decreased maternal age, poor antenatal care, multiple births, anaemia, poor nutritional status, other intrapartum risk like meconium stained and other complications. It was seen that the mortality rate was reduced when there was early identification of high risk cases and improved antenatal and perinatal care.

Research revealing Language Status in children with High Risk Factors

Chelvi (2007) found that the combined language age of the children with high risk such as very low birth weight and low birth weight with preterm children was delayed by 9 months when compared to the typically developing children.

Research relating Birth Asphyxia to Neonatal Encephalopathy, Low APGAR score before and after 5th Minute of Birth, Cognitive Impairment and Educational Performance

Odd, Rasmussen, Gunnell, Lewis and Whitelaw, (2008) found that children who had brief low APGAR scores before the 5th minute of birth and those who had prolonged low APGAR scores after 5th minute of birth had low IQ scores at the age of 18 years which is mainly exhibited at the later period of life as their educational demand increases.

Research relating Birth Asphyxia to Neurological Impairment, Psychological Status and Quality of survival

Thomson, Searle and Russell (1977) investigated the neurological and psychological status of the 31 children who had survived from severe birth asphyxia and was compared to their age matched control group. Out of 31 children, 29 did not exhibit any serious neurological or mental handicap where as 2 of the children had severe neurological and cognitive impairment. Hence quality of life will be improved in children who had survived from severe birth asphyxia when resuscitation is encouraged.

Research relating Birth Asphyxia to 5th Minute APGAR Score, Socio Economic Status and Biological Factors

Straube et al. (2009) investigated the association of 5th minute APGAR score with maternal socio-economic and biological factors and found that, a low APGAR score was commonly seen in overweight women and in women who were above 35 years of age where as socio-economic factors did not significantly influence APGAR scores.

Research relating Birth Asphyxia to Low APGAR Score and Maternal Socio Economic Status

Odd, Doyle, Gunnell, Lewis, Whitelaw and Rasmussen (2008) found that children who had the risk of a low APGAR score were more in the mothers who had low educational status and lack of awareness on birth asphyxia as a resultant of poor socio economic status.

Research relating Birth Asphyxia and Preterm to Cognitive Impairment and Language Impairment

Golightly, Sander and Raz (2003) found that children who had more than one high risk factors will exhibit have severe cognitive and language impairment when compared to those with a single high risk factor.

Research relating Low APGAR Score to Mortality, Neurological Impairment and Cognitive Impairment

Jerneck and Herbst (2001) found that infants with very low APGAR score at the 5th minute exhibited mortality, cognitive impairment or neurological impairment. The incidence rate varied depending on environmental factors.

Research relating Very Low 5th Minute APGAR Score and Preterm to Mortality

Lee, Subeh and Gould, (2010) found that neonates who had very low 5th minute APGAR score (0 to 3) and were born at the 24th to the 28th week of gestation had increased

mortality rate when compared to the those who were born after 28th week of gestation.

Research relating Very Low 1st Minute APGAR Score, Preterm and Very Low Birth Weight to Mortality

Genzel-Boroviczeny, Hempelman, Zoppelliand Martinez (2010) found that despite frequent intubations, preterm children who were born within 23 to 26 weeks of gestation with very low birth weight (500g) and very low APGAR score (0 to 1) at the 1st minute of birth had higher mortality rate especially males than those with an APGAR score above 1 at the 1st minute of birth.

Research relating Birth Asphyxia to Neonatal Encephalopathy, Cognitive Impairment and Educational Performance

Odd, Whitelaw, Gunnell and Lewis (2010) found that among the children who survived neonatal encephalopathy due to birth asphyxia, the children with symptomatic neonatal encephalopathy after resuscitation had exhibited cognitive impairment, poor language skills and poor educational achievement.

Research relating birth asphyxia and the risk factors of neonatal mortality

Lee, Mullany,Tielsch, Katz, Khatry, LeClerq and Darmstadt (2008) found that 9.7 out of 1000 live births died in southern Nepal in the year 2002 to 2006 due to birth asphyxia, maternal infections, premature births, multiple birth and poor socio-economic status of their parents.

Research relating birth asphyxia and hearing loss

Ohl et al. (2009) found that the sole cause of sensorineural hearing loss was attributed to severe birth asphyxia, neurological disorder, syndromes associated to cause of hearing loss, TORCH infections, any family history of deafness or when the infants have more than one high risk factor at birth such as low birth weight and preterm. However conductive hearing loss was found in infants with craniofacial anomalies such as cleft palate and ear aplasia.

Research relating Birth Asphyxia and Learning Disability

Bhate et al. (2006) found that the causes of learning disability can be genetic such as down syndrome and fragile-X syndrome, biological factors such as perinatal factors such as birth asphyxia, mechanical birth trauma, hypoglycaemia and prematurity, environmental and idiopathic.

Research relating birth asphyxia and visual impairment

Ronald et al. (1986) used instrumental analysis to detect the presence of visual impairment in children with birth asphyxia as these children are poorly identified due to involvement of multiple neurological impairments. The researchers found that by using cranial computed tomography and visual evoked potential mapping, children with cortical visual impairment were identified. The researchers could associate the effects of birth asphyxia to cortical visual impairment.

Research relating Birth Asphyxia and Attention Deficit Hyperactive Disorder

Gustafsson et al. (2010) found that children who were born in Sweden and diagnosed with Attention Deficit Hyperactive Disorder had biological high risk factors such as birth asphyxia (APGAR score of less than 7 at the 5th minute of birth) and preterm (less than 32 weeks of gestation) and environmental risk factors such as young maternal age and maternal smoking.

Research relating stuttering and birth asphyxia

Somefuna et al. (2005) investigated the causes for children with communication disorders such as hearing impairment, speech disorders (stuttering), language disorders and rhinolalia in the age range of 6 months to 15 years were birth asphyxia, seizures, meningitis, kernicterus, ototoxixity, otitis media effusion, cerebral palsy, measles, congenital deformity and others.

Research relating Birth Asphyxia and Seizural Disorder

Airede (1991) investigated 57 infants with neonatal seizures and found the cause of the neonatal seizures in these children was due to perinatal asphyxia, hypoglycaemia and preterm. However the outcome of the preterm children was poorer than the others.

Research relating Birth Asphyxia to Speech, Language and Hearing Issues

D'Souza et al. (1981) found that among the 26 children who have survived from severe perinatal asphyxia, only 1 child had sensori-neural deafness, whereas one-third of the children exhibited deficits in speech and language without any serious mental or physical handicap. However the authors suggested that the quality of would be better if detected early and treated adequately.

Studies relating Birth Asphyxia and Language Impairment

Stanton-Chapman et al. (2002) stated that children with specific language impairment had risk factors such as very low birth weight and birth asphyxia at birth and the environmental risk factors such as low maternal education, late or no prenatal care and high birth order.

Research relating Multiple Risk Factors and Early Language Development

Sidhu, Malhi and Jerath (2010) found that children who had biological risk factors at birth such as birth asphyxia, preterm, neonatal jaundice, low birth weight and environmental risk factors such as low maternal and paternal education status, low income, higher birth order, large family size, disadvantageous caste, absence of father, low level of occupation of the head of the family exhibited delayed language development.

Research relating Birth Asphyxia and Language

Beharelle, Dick, Josse, Solodkin, Huttenlocker, Levine and Small (2010) found that the children with early unilateral left focal brain injury children had either bilateral activation left and right superior temporal inferior parietal regions or unilateral activation left or right superior temporal inferior parietal regions instead of the left frontal and lateral temporal regions which is essential for language. The outcome was better in those with bilateral activation in terms of processing language.

Research relating the association of Birth Asphyxia to the APGAR Score, Time at which the APGAR Score reach 8, Cognition Pertaining to Language and Language Status

Shanthini and Athmacharan (2009) conducted a pilot study on the language status in the children with birth asphyxia. In this study, 640 children with birth asphyxia were subjected to a range of evaluations such as neurological evaluation, psychological evaluation, audiological evaluation and detailed

speech and language to rule out associated problems. Based on that, 15 children who met the inclusion criteria constituted the subjects of the study who were in the age range of 2 ½ to 4 years. All these children had an APGAR score of 7 at the 1st minute after birth. This study reveals that when the APGAR score reached 8 at 2nd minute there was no language delay. When the APGAR score reached 8 at the 5th minute there was a delay of 1 year in the combined language level. When the APGAR score reached 8 at 10th minute there was a language delay of 15 to 24 months.

III. NEED OF THE STUDY

In the last three decades several systematic studies have been carried out in children with birth asphyxia. Most of the researches have focused on either a single parameter and an issue or a group of parameters and their respective issues as a resultant of birth asphyxia. There are hardly any study that has been carried out in documenting the language status in the children with birth asphyxia by giving importance to the role of APGAR score, time at which the APGAR score reached 8, cognition pertaining to language and the language status. Even the little research done in these children has not been followed up to establish the language status of the children as they get older. There are hardly any comparative studies done between normally developing children and children with birth asphyxia have not been attempted. Besides that, there exists hardly any study that compares the language amongst gender. However in this study cognition is also given equal importance because it precedes language development (Piaget, 1954 as cited in Owens, 2001). So in order to address these issues mentioned above, the following objectives were set.

IV. OBJECTIVES OF THE STUDY

1. To check whether there is any deviance in the language status of the children with birth asphyxia in relation to their APGAR score, time at which the APGAR score reached 8 and their cognitive level pertaining to language as the subject's age increases.

2. To compare the language status of the children with birth asphyxia to that of the typically developing children with respect to their gender.

V. METHODOLOGY

This follow up study was done for dissertation, which was an extension of a pilot study conducted by Shanthini et al. (2009) that focused on analysing the language status of children with birth asphyxia without any other associated problems. Shanthini et al. (2009) reviewed 640 children with birth asphyxia (APGAR score of 7 or lesser at the 1st minute of birth) who were born in a private hospital in Chennai between 2004 and 2005. The records of these children were scrutinized and a series of evaluations such as neurological evaluation (Reflexes, Muscle tone and Motor abilities), psychological evaluation (Geschells Children Behavioural scale and Vineland Social Maturity Scale), audiological evaluation (Visual Reinforcement Audiometry or Conditioning Audiometry and Immittance screening) detailed speech and language (Modified 3 Dimensional Language Acquisition Test).

Out of the 640 children who had birth asphyxia, only 15 children (9 males and 6 females) in the age range of 2 ½ to 4 years did not exhibit any associated problems. A detailed speech and language assessment was done for the 15 children who were the subjects of the study. The evaluations revealed that 10 of them exhibited a delay in language acquisition. The present study is a follow up of all those 15 children after 1 ½ years to check the present language status in generating certain morpho-syntactic structures by comparing them with age and gender matched typically developing children who were also screened with the series of evaluations.

Subject selection: Clinical group

The clinical group included all the 15 children with birth asphyxia (APGAR score of 7 at the 1st minute of birth) without any associated problems identified in the pilot study. All the subjects were Tamil speaking children and they did not attend any formal speech and language therapy. All these children were in the age range of 48 to 66 months, with a mean age of 4.38 years and a standard deviation of 0.481.

Table 4

Parameters	Mean	Standard Deviation
Chronological Age	4.38 years	0.481
Developmental Quotient	93	0.755
Social Maturity	4.57 years	0.506

The mean and standard deviation of the Chronological Age, Developmental Quotient & social maturity of the children in the clinical group

The subjects were further classified based on the time at which they reached a normal APGAR score of 8. Out of the 15 children, 5 children obtained an APGAR score of 8 at the 2nd minute of birth, another 5 children obtained an APGAR score of 8 at the 5th minute of birth and remaining 5 children obtained an APGAR score of 8 at the 10th minute of birth. All the children have migrated to areas in Thiruchirapalli and Madurai districts of Tamilnadu and are presently studying kindergarten and 1st standard (primary 1) under the government sector.

Control group

An equal number of children, matched for age and gender were recruited to form the control group of the study. The mean age of these children was 4.38 years with a standard deviation of 0.481.

Table 5

Parameters	Mean	Standard Deviation
Chronological Age	4.38 years	0.481
Developmental Quotient	93.26	0.703
Social Maturity	4.512 years	0.481

The mean and standard deviation of the Chronological Age, Developmental Quotient & social maturity of the children in the clinical group

All the children in the control group were Tamil speaking children, selected from a kindergarten and primary school in Chennai. These children were screened to rule out any associated problems such as neurological impairment, sensory impairment, motor impairment, cognitive impairment and delay in speech and language. In total, 30 children participated in this study, 15 each in the clinical and control group.

Tasks given and material development

The deviances of language, if any, in the children with asphyxia were evaluated in relation to certain pre-selected morpho-syntactic structures. For this purpose, the tasks of general conversation and picture & live description were employed. In both the tasks, the use of case markers, tense markers, person marker, number and gender marker was targeted. The picture & live description task included answering targeted questions related to 46 black and white line drawn pictures and 4 live situations. These picture cards were taken from the study of Kavitha (2009), which focused on

analysing verb and noun morphology in spoken and written language of children with and without learning disability using Tamil as their native language. Black and white picture cards which are line drawn were used to avoid distraction in the children. In total, the description task included 50 test items with 50 questions. In the general conversation task, 50 questions were framed to elicit responses that would have the target morpho-syntactic markers as responses. This was included to verify whether each child produced the same structures in both the tasks or behaved differently in both the tasks. In total 100 questions were presented to both the clinical group and to the control group.

Table 6

Category No.	Category Name	Stimulus No.	Marker's Name	Marker
1.	Case Markers	1 & 2	Accusative	-ai
		3 & 4	Dative	-kku
		5 & 6	Instrumental	-a:l
		7 & 8	Sociative	-oda/-kuda
		9 & 10	Ablantive	-ilirundu
		11 & 12	Genitive	-o:da
		13 & 14	Locative	-il
2.	Present Tense Marker	15 & 16	-	-kkir-
3.	Future Tense Markers	17 & 18	-	-pp-
		19 & 20		-v-
4.	Past Tense Markers	21 & 22	-	-tt-
		23 & 24	-	-nt-
		25 & 26	-	-d-
		27 & 28	-	-in-
		29 & 30	-	-i-
5.	Person/ Pronoun Markers	31	1st person singular	na:n
		32	1st person plural	na:ngal
		33	2nd person singular	ni:
		34	2nd person plural	ni:ngal
		35	3rd person masculine	a:van
		36	3rd person feminine	a:val
		37	3rd neuter	adu
		38 & 39	3rd person honorific singular	avar/a:r
		40	3rd person honorific plural	avargal/al
6.	Number marker	41, 42, 43, 44	-	-kkal/-gal
7.	Gender marker	45 & 46	Masculine	-n
		47 & 48	Feminine	-l
		49 & 50	Neuter	-u

The categories and markers tested in the both the production task (Picture-live description task and general conversation task)

Data collection

Before commencing the recording, the children were made to feel comfortable. A good rapport was build before testing them to elicit best responses from them. The time taken to record each child was 2 ½ to 3 hours including the rapport building and completion of both the tasks. In the picture description task, the children were instructed to describe the picture in response to the question asked by the investigator. Reinforcements such as verbal and social reinforcements were given at a continuous schedule and tangible reinforcement was given at a fixed ratio schedule to encourage participation of the children.

Transcription

The responses of both the tasks for each child in the clinical group and the control group were transcribed verbatim and they were analysed for the presence or absence of the markers/structure in question. The phonological processes and the dialectal variations were not taken into account. To establish the validity of the analysis, the transcripts were reviewed by a trained Linguist.

Means of scoring for the tasks given

When the child gave the expected responses to the picture description task and general conversation it was considered as a correct response and a score of 1 point was given to both the tasks. When the child gave the expected response in one task and not in the other, cues such as binary choice, prompting and semantic cueing was provided. A correct response with the cues was also scored as 1. When the child gave irrelevant answers in both the tasks in spite of the cues given, it was considered as incorrect response and the child was scored 0 in both the tasks. These coded data were statistically analysed by using SPSS (Statistic Program for Social Science) software, version 14.0. The score obtained in both the tasks were represented in percentage.

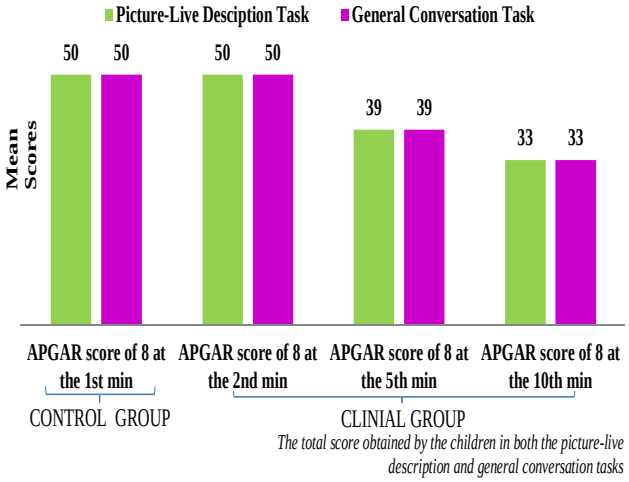
Statistical analysis

Pearson's correlation was performed to investigate the relation between the time at which the APGAR score reached 8 to the performance of the children in the picture description task and general conversation tasks as their age increases. Independent sample t-test was performed to investigate the role of gender differences in the performance obtained by the children from both the tasks. Post hoc analyses-Tukey's HSD (High Significant Difference) test was performed to check the language deviance of the children with birth asphyxia by comparing their performance in both the tasks with the age and gender matched control group.

VI. RESULTS

The total score obtained in the two tasks by each child in the control group who had an APGAR score of 8 at the 1st min of birth and 5 children in the clinical group who had an APGAR score of 8 at the 2nd minute after birth had a score of 100. This denotes that these children have acquired all the case markers, tense markers, person/pronoun markers, gender markers and number markers in the language. On the other hand 5 children who had an APGAR score of 8 at the 5th minute after birth had a score of 78 and the remaining 5 children who had an APGAR score of 8 at the 10th minute after birth had a score of 66. This denotes that children who had an APGAR score of 8 at the 5th and 10th minute after birth did not acquire certain markers in the language.

Figure 2



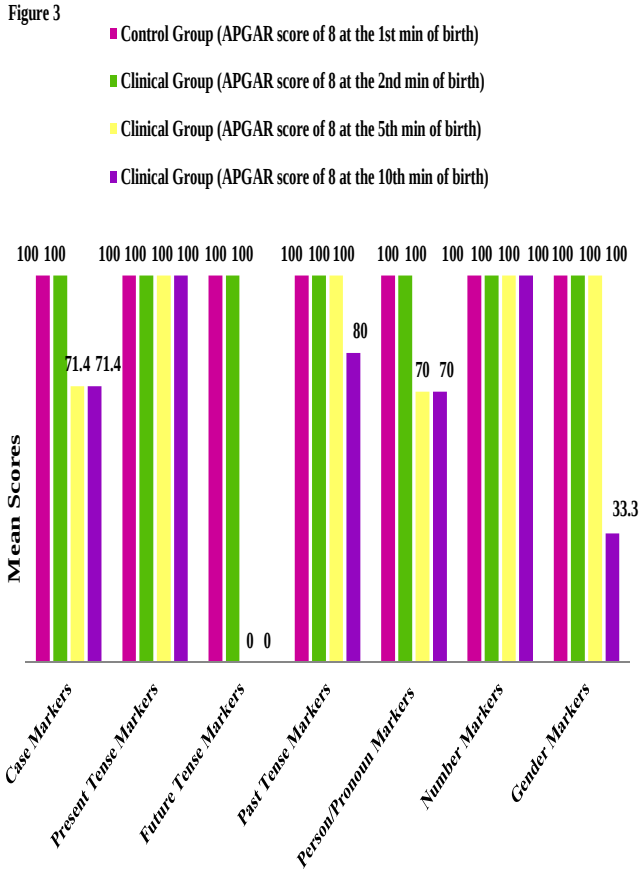
The total score obtained by the children in both the picture-live description and general conversation tasks

Figure 2, indicates the total score obtained by the children in the control and the clinical group in the picture – live description and general conversation tasks. The bar chart indicates that the children who are in the control group (5 children who had an APGAR score of 8 at the 1st min of birth) and 5 children in the clinical group who had an APGAR score of 8 at the 2nd min of birth obtained a score of 50/50 in both picture-live description and general conversation tasks. However 5 children who had an APGAR score of 8 at the 5th min had a score of 39/50 in the picture–live description and general conversation tasks and the remaining 5 children who

had an APGAR score of 8 at the 10th min had a score of 33/50 in the picture–live description and general conversation tasks.

Results based on the individual markers present in the language across the tasks

Figure 3



Overall markers attained by the control and clinical group in the production tasks

Figure 3 indicates the total score obtained by the 15 children in the control group (those who had an APGAR score of 8 at the 1st min of birth) and 5 children in the clinical group (those who had an APGAR score of 8 at the 2nd min of birth) for the individual markers in the picture–live description and general conversation tasks were 100.

However the total score obtained by the children who had an APGAR score of 8 at the 5th min of birth for the individual markers in both the tasks were 100 for the present tense markers, past tense markers, number markers and gender markers and had obtained a score of 71.4 for case markers, 0 for future tense markers and a score of 70 for person/pronoun marker present in Tamil.

The total score obtained by the children who had an APGAR score of 8 at the 10th min of birth for the individual markers in both the tasks were 100 for the present tense markers and number markers and had obtained a score of 71.4 for case markers, a score of 0 for future tense markers, a score of 80 for present tense markers, a score of 70 for person/pronoun markers and a score of 33.3 for gender markers present in Tamil.

Overall Result

Table 7

S.NO	AGE	GENDER	Time at which APGAR score of 8 was obtained	Language Status
1.	4;0	M	1st min	All the Case markers, Tense markers, Person/Pronoun markers, Number markers and Gender markers were acquired
2.	4;1	M	1st min	
3.	4;2	M	1st min	
4.	4;2	F	1st min	
5.	4;4	F	1st min	
6.	4;7	M	1st min	
7.	4;8	M	1st min	
8.	4;8	M	1st min	
9.	4;9	F	1st min	
10.	4;11	F	1st min	
11.	5;0	M	1st min	
12.	5;4	M	1st min	
13.	5;6	M	1st min	
14.	5;3	F	1st min	
15.	5;5	F	1st min	
16.	4;0	M	2nd min	
17.	4;0	M	2nd min	
18.	4;5	M	2nd min	
19.	4;3	F	2nd min	
20.	4;5	F	2nd min	
21.	4;5	M	5th min	Except Case marker (-ai), (-ilirundu), Person/Pronoun marker (avar/a:r), (avargal) and Future Tense marker (-pp-), (-v-) all the other markers were acquired
22.	4;9	M	5th min	
23.	4;11	M	5th min	
24.	4;8	F	5th min	
25.	4;8	F	5th min	
26.	5;2	M	10th min	Except Case marker (-ai), (-ilirundu), Person/Pronoun marker (avar/a:r), (avargal), Future Tense marker (-pp-), (-v-), (-in-) and Gender marker (-n), (-l), all the other markers were acquired
27.	5;5	M	10th min	
28.	5;6	M	10th min	
29.	5;1	F	10th min	
30.	5;6	F	10th min	

The language status of control and clinical group across both the picture-live description task and the general conversation task

Table 7 indicates the language status obtained from the control and clinical groups with respect to picture description task and general conversation task across their age, gender, time at which APGAR score reached 8.

Table 8

Dependent Variable	Group I - Control group	Group J- Experimental group	Mean difference	Standard error	*P value*
Total score for Picture-Live Description Task and General Conversation Task	Children with an APGAR score of 8 at the 1st min of birth	Children with an APGAR score of 8 at the 2nd min of birth	0.000	0.103	1.000
		Children with an APGAR score of 8 at the 5th min of birth	0.571*	0.103	0.000
		Children with an APGAR score of 8 at the 10th min of birth	0.571*	0.103	0.000

Post hoc analyses -Tukey's HSD test to check the language deviance of the children with birth asphyxia by comparing their performance in both the production tasks with age and gender matched control group

Table 8, indicates a high significant value obtained for children whose APGAR score was 8 at the 5th and 10th min when compared to the control group in the picture description task. However there was no significance found in children whose APGAR score was 8 at the 2nd min when compared to the control group in the picture-live description task and general conversation task.

Table 9

Variable	r value	p value
Picture-Live description task	**-0.952****	**0.000****
General Conversation task	**-0.952****	**0.000****

**** correlation is significant at the 0.01 level (2-tailed)**
*** correlation is significant at the 0.05 level (2-tailed)**

Pearson's correlation to investigate the relation between the time at which the APGAR score reached 8 to the age of the children, performance of the picture description task and general conversation tasks

This table above indicates that when the delay in birth cry increases the performance or the score obtained in both the

general conversation task and the picture description task decreases. This shows a negative correlation which is inversely proportional to the variables taken. This finding was highly significant. The pearson's correlation, r value was (negative) **-0.952**** and the p value was **0.000**.**

Table 10

Variable	*P value*
Time at which the APGAR score reached 8	0.010**
Picture-live description task	0.014**
General Conversation task	0.014**

Independent sample test to check the performance of the females both in the control and experimental group across the production tasks

This table indicates that the females had obtained a highly significance value of 0.014** with respect to the 2 tasks.

Table 11

Variable	*P value*
Time at which the APGAR score reached 8	0.001**
Picture-live description task	0.002**
General Conversation task	0.002**

Independent sample test to check the performance of the males both in the control and experimental group across the production tasks

This table indicates that the males had obtained a highly significance value of 0.002** obtained in males with respect to the 2 tasks.

VII. DISCUSSION

In this study the children who had an APGAR score of 8 at the 1st and 2nd minute exhibited a total score of 100 (maximum score) from both the tasks tested. This denotes that these children had acquired all the case markers (-ai, -kku, -a:l, -oDa/-kuDa, -ilirundu, -o:da and -il), present tense markers (-kkir-), Future tense markers (-pp- and -v-), Past tense marker (-tt-, -nt-, -d-, -in- and -i-), Person/pronoun marker (na:n, na:ngal, ni:, ni:ngal, a:van, a:val, adu, avar/a:r and avargal/al), number marker (-kkal/-gal), and gender marker (-n, -l and -u). On the other hand the 5 children who had an APGAR score of 8 at the 5th minute exhibited a total score of 78 from both the tasks. This means that these children have not acquired all the evaluated morpho-syntactic units. These children have acquired all except case marker (-ai), (-ilirundu), person/pronoun marker (avar/a:r), (avargal) and future tense marker (-pp-), (-v-). They have acquired all the other markers. Those children (5 children) who had an APGAR score of 8 at the 10th minute exhibited a total score of 66 from both the tasks. This denotes that these children have acquired all the markers in the language except case marker (-ai), (-ilirundu), person/pronoun marker (avar/a:r), (avargal), future tense marker (-pp-), (-v-), past tense marker (-in-) and gender marker (-n), (-l).

When this finding were correlated with the earlier pilot study it was seen that the children who had an APGAR score of 8 at the 5th minute after birth had a language delay of 12 months (Combined Language Age) where as the children who had an APGAR score of 8 at the 10th minute after birth had a language delay of 15 to 24 months (Combined Language Age). This finding could be either because these children were not given any therapeutic intervention to enhance language or it may be because of the delay in the onset of birth cry. In both of these studies, that is the earlier pilot study and the present follow up study, 4 parameters namely the APGAR score, time of birth cry, cognitive abilities pertaining to language and the language status have been given equal importance. Even in the control group were also because even children with mild developmental delay with a developmental quotient less than 90 and slightly delayed social maturity age attend normal kindergarten and primary school. Only when there a deviance from the other peer groups they join in some special school.

Many studies have given importance to the APGAR score and have stated that children who had an APGAR score of 7 had no associated problems but this does not hold good to all the children because many children who had an APGAR score of 7 have associated problems (Majeed et al, 2007). The APGAR score alone cannot give much information on the level or severity of impairment. Hence the APGAR score and time of birth cry along with other parameters such as the cognitive ability should be considered to arrive at a precise conclusion of the presence or absence of associated problems and to check the degree of severity.

In certain studies the APGAR score and the time of birth cry have been given equal importance. Those children with an APGAR score of 7 and had a brief onset of birth cry, that is, within 5 minute after birth had no associated problems such as neurological and cognitive impairment. However in children who had an APGAR score of 7 and had a prolonged onset of birth cry that is after 5 minute of birth had associated problems such as neurological and cognitive impairment (Odd et al, 2008; Paneth, 2010). Jerneck and Herbst (2001) have also revealed that children who had a low APGAR score at the 5th minute after birth are most likely to have mortality neurological impairment, cognitive impairment or both cognitive and neurological impairment.

All these manifestations depend on the level of APGAR score obtained by the children at the 5th minute of birth. However, while documenting the time of birth cry to check the associated problems such as mortality rate, neurological and cognitive problem, the classification of the time of birth cry as brief (within 5 minute after birth) and prolonged (after 5 minutes of birth) is considered to be sufficient, but to check for finer associated problems such as language development, the time of birth cry should be very accurate while documenting. This is because in this present study and the earlier pilot study done to check the language status in children with birth asphyxia it is seen that the onset of birth cry plays a vital role in differentiating who will have adequate language development and who is most likely to have difficulty in acquiring age adequate language development.

Kavitha (2009) found that the children with learning disability and had history of birth asphyxia had difficulty acquiring all the markers in the language when compared to the typically developing children. From the findings it is clear that, children who had birth asphyxia at birth are prone to have delay in the development of language. This has been supported in a study done by Sidhu et al. (2010) which revealed that children who had risk factors such birth asphyxia and other risks exhibited marked delay in the development of language. Stanton-Chapman et al. (2002) stated that one of the early risk factors for language impairment was birth asphyxia. The language development will be significantly delayed when there are more than one associated problem and depending on the severity of the problem (Odd et al, 2010).

Implications of the study

From this study, children who have survived birth asphyxia and had no associated problems may have language delay. This can be attributed to the level of APGAR score, time of birth cry, cognitive level pertaining to the language development and their language status. This study is the first of its nature where it had addressed the relationship between all the 4 parameters. In most of the studies done on covering the issues on birth asphyxia, the APGAR score at 1st min, 5th

min, 10th min, 15th min and 20th min after birth was given much importance. This is because the APGAR score rarely reach 8 and above at the 2nd min of birth. In this study the 2nd min of birth cry is given equal importance as the 1st, 5th and 10th minute of birth cry after birth. It serves as a basic guideline for early identification.

Limitations of the study

There was limited sample size hence non parametric test namely Pearson's correlation was used to obtain qualitative data and the differences could not be noticed in children with an APGAR score of 8 at 1st minute and at the 2nd minute. Percentages were calculated to indicate the markers attained by the children in the production tasks. However, it did not give much information as the scoring allotted in the production tasks were only binary in nature (0 or 1) and the results of the study could not be generalized to all the children who had mild birth asphyxia. Dialect variation and phonological processes were not taken into account in this study. Although there were equal number of males and females in the control and the clinical group but when grouped in terms of the time at which the APGAR score reached 8 were not proportionate. Hence the level of significance was much higher in males than in females.

Video recording could not be done for the clinical group due to interrupted electrical facilities and poor room acoustics. The picture cards and the framed questions to elicit general conversation used in this study were not standardized but there were designed to elicit the appropriate morpho syntactic structures. Familiarization of the tasks and cues such as binary choice, prompting and semantic cueing was permitted to elicit appropriate responses from the child. Socio–economic status should have been documented in both the control and the clinical group as the clinical group had low socio economic status whereas the control group had high socio economic status. The children in the control group are studying in a kindergarten or primary school in Chennai where as the clinical groups are studying in government school where "Activity Based Learning" (ABL) is practiced. Although the control group and clinical group were exposed to both English and Tamil, the level of exposure varied depending on the place where they reside, the immediate linguistic environment and their need to communicate in a particular language say Tamil. Biological maternal factors should have been emphasized.

Future directions

These children can be followed up further to check whether the language delay still persists or to check the language status of these children after providing appropriate therapeutic intervention. Studies can be done on other components of language say pragmatics. More studies should in this field to bring reliable results as birth asphyxia is one of the major high risk factor which is of a great concern these days due to its increasing incidence rate. Upcoming studies should consider and implement the limitations of this study.

VIII. CONCLUSION

The study concludes that 15 children in the control group (the typically developing children, who had an APGAR score of 8 at the 1st min after birth) and 5 children from the clinical group who had an APGAR score of 8 at the 2nd minute after birth had acquired all the case markers, tense markers, person/pronoun markers, gender markers and number markers of the language. In contrast, the remaining 10 children from the clinical group (5 children who had an APGAR score of 8 at the 5th minute after birth and 5 children who had an APGAR score of 8 at the 10th minute after birth) did not acquire certain markers of language. This study also shows a strong association between the APGAR score, time of birth cry, the cognitive abilities pertaining to language and the linguistic aspects in terms of acquiring the morpho-syntactic structures of the language. From the study it was seen that there were no significant age and gender differences as the sample size was small.

The findings of this study can be utilized positively for researchers who would like to conduct more studies in this field. As this can be a basic guideline for them to document the educational or academic status of children who had birth asphyxia without any other serious associated problem with respect to the parameters emphasized in this study. This study can be used for the purpose of early identification and intervention not only in health perspective but will promote early educational intervention programs for this population.

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