Infant Perceptual-Motor Development

3-4 months (12-21 weeks) period

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Overview

During the 3-4 month period infants spend more time in an alert awake state than before, allowing them more time to observe, explore and interact with the social and physical environment

Socially they are becoming aware of their ability to engage parents and other family members, are learning how to attract their attention and keep the social interaction going using smiles, facial mirroring (imitation) and vocalization..

Their innate curiosity coupled with the ability to see clearly over longer distance draws them to paying attention to people and events in the environment (Brazelton 2006)).

Their ability to self-regulate their levels of arousal is improving as they learn to self soothe by sucking their hands and turn away from visual events that they find unpleasant. They start to retrieve a pacifier and return it to the mouth.

The 3-4 month period is characterized by the infant's increasing ability to steady the head and trunk in the midline, and produce goal directed, purposeful movements with the upper and lower extremities. The infant is learning to stabilize the head and trunk in a way that adapts to the ongoing spontaneous and goal directed actions of the extremities.

Postural control mechanisms are becoming increasingly variable and complex as the infant learns to integrate and use ongoing sensory information about the orientation of the body relative to environment (including support surfaces) to anticipate and predict destabilizing forces that occur with goal directed actions (Haddad er al 2016).

It also marks the transition from a more extended posture in supine seen in the 2-3 month period to more effective control of flexion of the neck and trunk as the infant engages in visual, manual and foot exploratory behaviours.

General and fidgety movements

At this age fidgety movements (FMs) can still be observed. FMs are small movements of moderate speed with variable acceleration of the neck, trunk, and limbs in all directions They may appear as early as six weeks after term, but usually occur from around 9 weeks until 16–20 weeks, occasionally even a few weeks longer. They fade out when antigravity and intentional movements start to dominate. (Einspieler et al 2014).

Head control and neck movements

During the 3-4 month period the infant's ability to maintain the head in the midline becomes fully established. This allows them to visually focus on people and toys presented in the midline.
The infant has learned to flex the head on the neck as the deep neck stabilizer muscles become more active and are able to balance the activity of the sternocleidomastoid muscles (which tends to extend the neck with bilateral activation).

Flexion of the head on the neck also allows the infant to look down to bring objects that are held in the hands into the centre of the field of vision for detailed inspection (foveal vision).

The infant now easily turns the head through full range of motion, keeping the head in flexion, without associated side flexion seen at an earlier age. Rotation of the neck does not affect the position of the extremities.

The infant is also able to rotate and extend the neck to look at an object to the side and above the head.

Being lifted

During the 3-4 month period infants increasingly anticipate being lifted when they see the caregiver preparing to pick them up. This caregivers's intention is signalled by the her hands moving towards the infant's chest who starts to recruit the neck and trunk muscles in anticipation of being lifted.

As the infant's neck strength increases, caregivers provide less support for the neck when they lift the infant.

Infants tends to have better control of neck lateral flexion and extension than flexion against gravity. Turning infants as they are lifted allows them to maintain control of the position of the head.

Pull-to-sit

Increasingly infants anticipate being moved from supine into sitting when the caregiver grasps and pulls on their hands. (This pull-to-sit manoeuvre is often used to assess head control.) The infant flexes the neck and trunk, recruits the upper extremitiy (UE) muscles in response to the traction on hands, and lifts the lower extremities (LEs) up off the support surface.

When tipped backwards from sitting the infant is able to flex the neck to control the position of the head as the torso is lowered.

Supine

When placed in supine on a firm flat surface healthy TD infants are very active, with repeated bouts of kicking, reaching for toys within easy reach and actively using the hands and feet to explore the surrounding surfaces and their own bodies. They are very curious and eager to know what is going on around them turn their heads to look at interesting and novel events in the environment.

This activity is important for strengthening trunk and extremity muscles. Infants with high activity levels of the UEs as measured by full-day wearable sensors have been shown to have higher cognitive, language and motor scores (Shida-Tokeshi, 2018).

This period also sees an increasing ability to stabilise the trunk when moving the extremities allows the infant more control over their increasing tendency to engage in intentional and goal directed reaching and exploratory movements of the hands and feet.

Trunk stability in supine

The 3-4 month old infant's ability to hold the trunk steady when moving the extremities is improving. In typically developing centre of pressure (COP) excursions and variability are variable and complex, indicating that the infant is able to adapt muscle activity in a flexible manner to support ongoing extremity movements, including reaching for toys (Duising st al 2014).

The trunk is held steady and symmetrical when moving the upper and lower extremities, providing a stable base for adapting the movements for foot and hand reaching.

Upper extremity and hand actions

During **moments of relative quiet** 3-4 month old infants assume a variety of UE postures, sometimes with the shoulders in abduction and the extremity held away from the torso but frequently with the hands together in the midline.

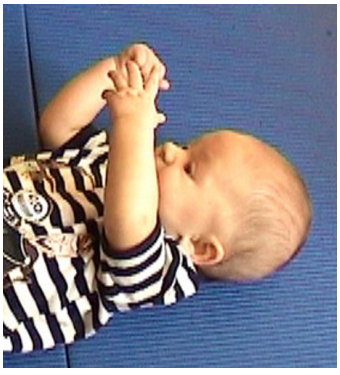
The tendency to bring the hands together in the midline is particularly prominent at the beginning of the 3-4 month period. Infants will visually inspect them for long periods of time.

This visual attention is aided by the infant's ability to flex the head on the neck and at the same time look downwards to bring the hands into the centre of the field of vision for a clearer view.

Reaching towards a toy presented in the midline is bilateral, with one hand usually making contact before the other.

The 3-4 month old infant has learned to grasp a toy with one hand and use the fingers of other hand for manipulation and exploration.

Infants continues to explore their bodies, clothing and surrounding surfaces with their hands and feet.



Lower extremity actions

The 3-4 month old infant has acquired the ability to move the LEs in a variety of ways that reflect the ability to flex and extend the hips and knees in different combinations. This ability to disassociate hip and knee movements differs from the tendency for the strong intra-limb association in 1-2 month old infant.

LE posture during periods of relative quiet

The 3 month old infant may lie with the hips and knees flexed, with the feet lifted up off the SS. This is associated with posterior pelvic tilt. At this time hip flexion and extension are associated with some hip abduction.


Over the next weeks the range of hip extension increases and hip abduction in extension decreases. Crossing of the feet is frequently seen.


The 3-4 month infant will often put one or both feet flat on the SS with the knees flexed. Pushing down on the SS with both feet does not yet result in lifting the buttocks up.


Pushing down with one foot leads to extension of the ipsilateral hip with forwards rotation of the pelvis. This action may initiate rolling to the side.

Periods of repeated unilateral and reciprocal kicking are still seen. The trunk is held steady and is symmetrical during periods of active kicking.

Changing the support surface influences LE actions

Infants quickly notice a change in the support surface and engage in exploratory LE behavior,

Rolling

Rolling from supine to lying on the side is becoming more frequent. The infant uses a variety of patterns to initiate rolling. In the sequence of frames below you see Will initiating rolling by reaching across the body to reach a toy. arm and as he brings his forwards he extends his neck and trunk. At the same time he pushes away with his right foot which helps to shift his weight to the left.

Will initiates rolling back onto his back by flexing the right hip and knee and at the same time extending his left hip and knee, a manoeuvre that destabilizes his trunk and he topples over backwards. The momentum of the "falling" trunk is counteracted by reactive trunk flexor muscles activity.

Prone

At the beginning of the 3-4 month period, infants lie in prone with the hips in abduction and lateral rotation providing a wide base for the pelvis-lower extremity region.

The infant lifts the head up to about 45 degrees using the muscle strength of head, neck and thoracic extensors. At this time the lumbar extensors are not activated.

The UEs are positioned in line or just ahead of the shoulder with the elbows flexed.

This is a fairly stable position, and limited movements of the extremities means that equilibrium is maintained. The excursions of the COP can clearly be observed as the postural system explores the stability boundaries of the position and learns to respond to movements of the head and extremities.

Over the next weeks, the resting position of the extremities changes, with the shoulders in more flexion and the hips more extended and adducted.

The infant actively xplores different ways to use the UEs for support and find ways to be more mobile in prone. This exploratory activity is associated with changes in the alignment, weight distribution and stability of the trunk:

1 The U Es are positioned ahead of the shoulders

2 Pushing down on the UEs allows the infant to lift the head and shoulder girdle higher than before. Extension of the spine now includes lumbar extension.

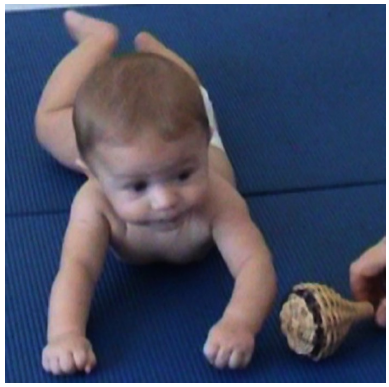
3 Lumbar extension is associated with hip extension and adduction, bringing the thighs in line with the pelvis. This narrows the base of support (BOS) decreasing stability from side-to-side.

3 The COP moves in a caudal direction.

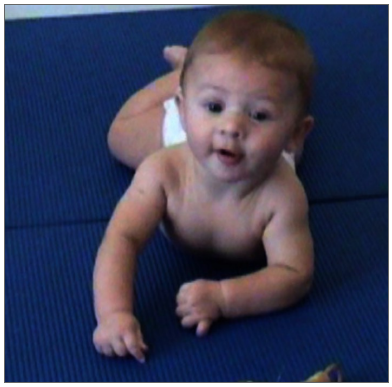
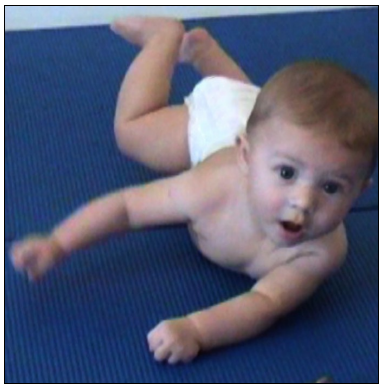
4 The hands are lightly fisted most of the time, but sometimes the fingers are extended and pointing of the forefinger is seen.

The infant explores different ways to exploit the contact between the SS and the forearms and hands to move in different directions.



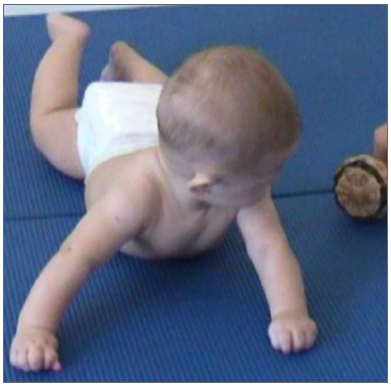


The infant experiments with lifting one hand up off the SS, which often leads to collapsing onto the contralateral shoulder.

The infant also starts to experiment with pushing up on the hands and extending the elbows.


Turning the head is associated with lateral weight shift over the hands towards the UE on the face side.



Sitting with support

During the 3-4 month period the infant's ability to maintain trunk extension when supported in sitting improves. The infant has learned to use UEs to provide additional support and in this way they become part of the postural system.

At the beginning of the 3-4 month period the infant is able to hold the head erect and steady when firm support is provided at the upper thoracic level. The neck and thoracic extensors are active to maintain the upright position of the head (Saveedra et al 2012).

If the support is provided at waist level, the infant may recruit the scapula retractors to support the thoracic extensors. Extension of the shoulders also shifts the centre of mass (COM) of the head, arms and trunk in a posterior direction, reducing the gravity torque on the spine.

When support is provided at the waist level the infant is able maintain thoracic extension for a few seconds before collapsing forwards. The lumbar muscles are not active.

The trunk is unstable with prominent sway activity as the postural system works to steady and balance the head and chest on the stabilised lumbar spine and pelvis.

The infant is able to counteract forward sway of the trunk and thoracic extensor muscle activity with some activity in the hip extensor muscles (hamstrings).

The response to a sway in a posterior direction is poor, and the infant easily falls backwards. However, the rapid posterior movement of the head and trunk will usually recruit a moderate reactive balance response in the trunk and UE flexors (Hedberg et al 2005)

At 3 months the infants may also start to prop themselves up on the hands for brief periods when the trunk is tilted forwards.

Over the next weeks the infant's sitting abilities improve rapidly, with improved postural control in the saggital plane and the recruitment of the lumbar extensor muscle to support the thoracic extensors in maintaining the trunk erect.

Balance control in the frontal plane is still poor and without some support the infant falls sideways.

Sitting with the trunk upright remains unstable and difficult to maintain but the infant is learning to use the UEs as props to support the trunk when it is tilted forwards.

Sitting on a caregiver's lap

At this age infants are often held in sitting on a caregivers lap, allowing the infant to look around. Caregivers adapt the amount of support they provide in a responsive manner, while at the same time active infants learn to use available support surfaces to help maintain an upright position.

As this age infants become increasing interested in using their new found ability to successfully reach for, grasp and explore interesting objects. Their attention tends to be fully focussed on exploring the toys, and they do not seem to be very interested in maintaining their balance. The pictures of Will sitting on a caregiver's lap illustrate this point very well. Will trusts her to keep him upright and safe while he gets on with exploring the toys.

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