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THE DEVELOPMENT OF OCULAR FIXATION

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Abstract
Literature presented over the past ten years which relates to the development of ocular fixation is reviewed. From consideration of the results of this survey, the importance of the human face is emphasised in the development of fixation or visual attention and therefore visual, physical and social functions of both the normal and handicapped infant. Possible strategies to permit maximum visual development of handicapped or institutionalised children are discussed as the results of these findings.

Key Words
Fixation reflex, binocular reflexes, child development.

In the course of clinical practice, orthoptists are frequently being asked for help by parents and by members of associated disciplines, who are involved in the overall development of the patient, especially where the patient is handicapped. An analysis of the reported studies of visual attention and fixation of infants is presented to assist orthoptists in these areas. As orthoptists we are aware of how important it is to accurately test the fixation ability of the eyes to disclose the maximal information about an ocular deviation. To encourage the use and development of the function, it is also important to find which objects most interest the human baby.

FIXATION TARGETS

As the true visual acuity of the human baby is not known but is generally considered less than maximal, it may be advisable to think of fixation in the new born as being visual attention which then develops to fixation. Many articles such as that presented by Maurer and Salapatek[1] report the work of Fantz who, between 1963 and 1967, revealed in several studies the preference of new born infants to fixate or attend the human face rather than a coloured disk, bull's eye target, newsprint, a red square, or a lighted orange globe.

Goren *et al*[2], following this important work pioneered by Fantz, studied 40 newborn infants whose mean age was 9 minutes, and found that they significantly turned their head and eyes to follow a face-like stimulus (where the arrangement of eyes, nose and mouth closely approximated the normal face) but not to follow a face-like arrangement (a shape with the mouth situated on the forehead and one eye situated on the chin), or a blank form.

In further defence of the face as a fixation object of choice, Ellis[3] in a review of "face recognition" reports several studies which tested memory recognition of pictures by adults. The study compared the ability to memorise and recognise faces, snow crystals, buildings, dogs and inkblots. The recognition of faces was always best. The facial features were ranked in the order recognized, i.e. eyes, nose, mouth, lips or chin, hair and ears. Infants were found to concentrate on the eyes then the mouth. Inverted faces were found more difficult to recognise and, interestingly, infants aged 5 to 6 months could differentiate a novel face from a normal face except when the pictures were inverted. (Perhaps this is a good reason for not standing behind or above a baby's head.)

Earlier this year in Brisbane Creig Hoyt[4], when discussing "how babies see", commented that the face was a good test to use to assess the fixation ability of a baby. He suggested using a paddle twice the size of a ping pong bat with a face painted on it, as a fixation target. As there is a wide experimental backing to this choice of target, it is easy to see why such an object should be

successful. It also seems logical that the choice of a toy with features that resemble the human face would be an ideal fixation target.

Hoyt however suggested that toys have limitations as some babies may be frightened or upset by our choice. To reduce this problem, the use of a toy from the patients home may help.

Within our family both our children at an early age have demonstrated a preference, out of quite a range of toys, for those which are large and have facial features that closely resemble the human face. In the absence of the real human each child has spent considerable time gazing at, chatting to, then ultimately forming an attachment to the facsimile. Their choice is clearly predictable from the quoted experimental studies.

It therefore seems logical that the use of a toy with facial features resembling those of a human may prove useful in institutions with limited staff or in clinical practice where visual fixation is to be encouraged as the first step in normal ocular function. This choice of toy will also prove a good present for a new baby!

Dr. Serfontein in his paper[5] described the need for sensory input to activate attention as a developmental stage in infants. Thus by attracting visual fixation or attention we may not only be stimulating visual function but also, by the continuous use of the appropriate stimulus, promoting a stage in the overall development of a child.

Having established that the human face has such attraction for the baby, workers in the experimental field have turned to the analysis of the features which most attract infant fixation.

Again, Fantz and Miranda[6] have revealed that infants under 7 days of age are attracted to curved rather than straight objects. Ruff and Birch[7] studied infants aged 13 weeks to see their response to a design made up of concentric, curved and multi-directional lines. Each of these dimensions was, in varying degrees, found to be effective in attracting fixation.

This information suggests that in the absence of face-like fixation objects, for both assessment and training of ocular function, objects made up of curved multi-directional lines should be used. Certainly, as stated by Hoyt, the favourite fixation light does not fit sufficiently with this criteria to hold the infants attention and, in addition, the glare of the light is likely to deter the patient.

CHRONOLOGICAL DEVELOPMENT OF FIXATION

The following summarises the experimental evidence on how the fixation of human infants functions between birth and 14 months of age:

WEEK 1:

Hoyt[4] stated that 94% of babies fixated the human face *within 30 seconds* of birth. The pattern of fixation shows that the eyes look at the edge of the face near the ears.

Goren *et al*[2] found that at a mean age of *9 minutes,* babies significantly turn their eyes and head to follow a face.

Slater and Findlay[8] found that babies with an approximate mean age of *6 days* could converge accurately to test targets 10 and 20 inches from the eyes. A target 5 inches from the eyes produced monocular fixation only.

WEEK 3:

Haith *et al*[9] stated that babies fixated 22.1% of the time they were studied.

WEEK 4:

Maurer and Salapatek[1] found babies looked at their mother less than other test faces of unknown males and females. Their fixation was mostly off the face and when on the face, their eyes moved around the border predominantly to the chin and hairline.

WEEK 8:

Maurer and Salapatek[1] found that whilst babies in this age group changed their fixation as often as babies at four weeks, they looked on the face more, moving their eyes around the border. When fixating inside the face, they looked most frequently at the eyes then the mouth.

Scaefe and Bruner[10] assessed an infant's ability to interact with an adult who, after establishing eye to eye contact, cued the infant to look at laterally displaced fixation objects. At this stage there was a 30% positive response.

Hill[11] elicited horizontal optokinetic nystagmus in all infants tested at this age.

WEEK 11:

Haith *et al* found that by this stage fixation had increased to 89.9% of the time under study. When the subject being fixated spoke, the infants fixation become more confined and particularly so to the eye area.

Hill[11] found that by this age, 100% of infants tested could converge, and demonstrate horizontal and vertical saccades, although with some overfixation.

MONTH 5:
Wilcox and Clayton[12] noted that regardless of facial expression, movement of the face attracted better fixation.
MONTH 11-15:
Scaefe and Bruner[10] found that by this age the positive response to a cue from an adult to look laterally was 100%. The authors suggest that the older the infant, the more they require active human interaction.

It can be seen from the above that fixation functions at birth. It is not until the baby is eight weeks old that he endeavours to look inside the border of the face and then mostly at the eyes, then the mouth. At this same age of eight weeks babies start to interact with adults and react to visual clues to look laterally.

To assist the development of fixation it is apparent that the human face or its substitute is necessary from birth. It is possible that a more passive form of stimulus, such as a toy, will suffice for the first eight weeks. Towards the end of this period and definitely by week eleven, the time a baby will fix has increased to around 90% of the time and a speaking subject helped to concentrate the fixation. The work of Ellis has shown that it makes no difference whether the face is black and white or coloured, nor whether the pose is frontal, three quarter, or full profile. However, as Wilcox and Clayton[12] have shown, an active human face is necessary to attract attention. In the absence of parents perhaps a video tape of an adult talking may help. As it has been noted that babies from 4 weeks can differentiate strangers and tend to look at these faces more often than the familiar human, the help of voluntary workers to talk to the institutionalised infants could be of great value in assisting both ocular and social development.

CONCLUSION

The experimental studies by workers outside the field of ophthalmology have demonstrated how valuable the human face is in attracting ocular fixation or attention. Usually the normal home environment provides sufficient stimulation to develop the fixation function. However where this is not possible the use of toys, films, television and volunteer workers may assist.

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