Can measures of infant habituation predict later intellectual ability?

By the end of the 1970s, about 50 years of research had shown fairly clearly that prediction coefficients from measures of infant behaviour to later measures of intelligence in childhood were so low as to indicate that, except in extreme cases such as severe subnormality, the early measures had no predictive validity.[1 2] From about this time, however, researchers began to question the nature and validity of the infant tests on which these findings were based. It was argued that the 'mental scales' on these tests primarily measured perceptual and motor development, rather than mental or cognitive growth, and there is little reason to expect measures of such abilities to predict later IQ.[3 4]

Accordingly, the search began for cognitive or information processing measures of infant performance which might more reasonably be considered to tap abilities that are similar to, and may be predictive of, the abilities measured by the childhood intelligence tests. A major focus of this research has been on measures of visual information processing and attentiveness, and it has become clear that a moderate degree of predictability may be possible, leading some to the view that the 'promise of greater predictive accuracy using recognition memory and habituation rate represents one of the most exciting contemporary fields of inquiry'.[5]

Problems with standardised infant tests

One of the best known and most widely used tests of infant development is the Bayley scales of infant development (BSID). In the second edition of these scales published in 1993, many items on the mental development index appear to measure perceptual-motor rather than mental or cognitive development. At 4 months the items include: #36 'eyes follow rod'; #44 'uses eye-hand coordination in reaching'; and #45 'picks up cube'. At 12 months the items include: #73 'turns pages of book'; #79 'fingers holes in pegboard'; and #97 'builds tower of three cubes'. By 2 years of age such seemingly perceptual-motor items are fewer in number and they have been replaced with a preponderance of items that would generally be considered more mental or 'cognitive': verbal comprehension, recall of geometric forms, and comparison of masses. From about 2 years of age the predictive validity of the BSID increases.[2 6] Similar comments apply to other well known tests of infant development, such as the Griffiths' scales.[7]

Several studies have introduced programmes in which infants at risk of intellectual retardation have been given educational intervention designed to enhance their cognitive development. At the end of the first year these groups did not seem to differ from non-intervention control groups.[8 9] A likely interpretation of these findings is that the mental scales used to evaluate the effectiveness of these programmes were simply not measuring mental or cognitive growth and there is therefore a great need for a valid test of infant cognitive development.

Visual information processing

Control of attention, memory formation, and the ability to process information quickly and efficiently have traditionally been conceived of as being central to mature cognitive functioning.[10 11] In the search for predictors of later intelligence a major focus has been on measures of visual information processing and attentiveness as these appear to be measuring these abilities: 'attentiveness reflects not only the detection of information but also the ongoing processing of that information and the status of the relation between the new information and the child's existing knowledge'.[12] Measures of habituation to visual stimuli in particular have been seen as potential predictors of later intelligence.

Habituation is an aspect of learning in which repeated presentations of a stimulus result in decreased responsiveness. When an infant is placed in an otherwise homogeneous environment and shown a visual stimulus the stimulus will initially attract the infant's attention, but as time passes the infant's attention will wane (as measured by reduced looking). Habituation refers to this decrement in visual attention and measures of this decrement reflect memory formation (of the now familiar stimulus), and therefore the processing of information from the stimulus, and may also be an indication of infants' ability to inhibit attention to the familiar stimulus.[13]

For several other reasons measures of habituation have been seen as potential predictors of later intellectual functioning: (a) there are interage differences in speed of habituation, with older infants taking less time to reach a criterion of habituation than younger infants,[14] and there are also intra-age differences; (b) infants who habituate in shorter times have been found to process information more rapidly and more efficiently than 'long lookers'[15]; and (c) infants 'at risk' for cognitive delay or handicap habituate less effectively than non-risk infants matched for age.[16–18]

Psychometric considerations

There are many different habituation procedures and many different dependent measures that can be drawn from them.[19] An important enterprise is to establish the psychometric adequacy of these measures, particularly by examining their test-retest reliabilities. Those measures that give the best reliabilities are likely to be the best potential predictors because if a measure does not correlate with itself it is unlikely to correlate well with other concurrent or future measures.

Several groups of workers have assessed the short and long term reliability of various measures of habituation in the first year after birth[20–22] and the results are both encouraging and discouraging. What is encouraging is that measurements at points close in time (separated by a few days or weeks) tend to give reliability estimates in the range r = 0.40–0.60, but what is discouraging is that measurements separated by a month or more tend to yield lower estimates, with r values in the range 0–0.20. Thus these infant measures tend to have low test-retest reliabilities and this will inevitably limit the maximum predictive correlations that might be found.

Predictive validity of visual information processing

Three measures can be distinguished which have some predictive power: (a) visual recognition memory (preferences for a novel stimulus after a brief look at a 'familiarised' stimulus); (b) the time taken to reach a criterion of habituation and associated measures (such as the duration of the longest single or peak look); and (c) the duration of individual fixations to visual stimuli, independent of habituation. There are many studies that have reported predictive correlations and several reviews of these studies are available.[3 19 23] The measures predicted are

usually the scores of the subjects on childhood intelligence tests, and the delay between testing as infants and testing as children can vary between months and several years. The predictive correlations that have been reported occasionally approach 0.6, but are usually in the range 0.3–0.5, with a median correlation of around 0.45.[23]

Failures to replicate and the 0.05 syndrome

Lécuyer[24] refers to what he calls 'the 0.05 syndrome' and points out that 'It is difficult to publish an experimental paper if no statistical tests reach this magical level of significance. So, how many studies exist that show no correlation between infancy and childhood measures?' One failure to replicate was reported by Lewis and Brooks-Gunn,[2] who found the rate of habituation in 3 month old infants to be predictive of the 2 year Bayley mental development index for one group of 22 infants ($r = 0.61$), but for a second group the identical measure gave a non-significant negative correlation of −0.18. In another study with 226 3 month old 'at risk' infants, 11 measures of looking were extracted and few of these correlated either with the Bayley mental development index at 2 years or with several cognitive tests at 4.5 years.[25]

One finding that is relevant is that the size of the predictive correlations to be found in the literature is correlated with sample size ($r = 0.6$).[3] The most reasonable interpretation of this is that very high and very low correlations are likely to be found with smaller samples and the studies finding low, non-significant correlations are not likely to be published. What this means, unfortunately, is that the published predictive correlations are almost certainly a biased sample of the whole research enterprise and are almost certainly an overestimation of the 'real' predictive correlations. Data have been collected from 420 infants who, at 4 months old, completed a habituation task as part of the Avon longitudinal study on pregnancy and childhood and they have subsequently been tested on later measures of language acquisition and abilities, and at 4 years on the Wechsler preschool and primary scales of intelligence. This is the largest sample that, to date, has been tested on a habituation task and at the time of writing the ability of the habituation measures to predict the later outcome measures has not been assessed: these data will eventually give a clear indication of the usefulness of measures of habituation as predictors.

Predictors other than visual information processing

Many studies have used measures other than those derived from visual information processing. These measures include differential vocal responsiveness to the mother and strangers, visual anticipation, the mother's encouraging attention, cross modal transfer, symbolic play, means-ends problem solving, perception of causal relations, and various measures of language development.[11 19 26] These studies are not reviewed here, but at present it seems reasonable to conclude that (with the exception of the language measures, which are inevitably taken in late infancy) at present none of them has been shown to have a greater predictive validity than measures of visual information processing.

Theoretical implications

Twenty years ago the poor long term predictive validity of infant tests led to theoretical views that emphasised the discontinuity of intellectual functioning from infancy to childhood: 'No science can predict accurately qualities which have not yet made any appearance in the development of the pre-school child'.[27] Thus it was reasonable to argue that the types of intelligence we wanted to predict, and which would be important in the school years (language, numeracy, thinking, problem solving, and reasoning) developed in the post-infancy years and that measures of intelligence in infancy (if it existed) would not predict these later appearing abilities.[28]

The demonstrations of developmental continuity (however modest the predictive correlations) mean that we can probably reject such extreme models and suggests that it is reasonable to look for genuine precursors of childhood intellectual abilities in infancy. Predictive correlations of the magnitude reported, however, give ample scope for theorists who wish to emphasise discontinuity and open endedness, rather than continuity of development.

Social and cultural influences on IQ

However good our measures of infant function, they can only give an indication of mental growth or cognitive ability at the time of testing. Clearly, later IQ will be considerably modified by social factors[19] and a valid test of infant cognitive abilities will be of inestimable value in allowing the quantification of the role of such factors in the early months after birth.

Conclusions

Measures of visual information processing taken in infancy have been shown to predict measures of intelligence in childhood. The predictive correlations are, however, modest (usually in the range 0.3–0.5) and correlations for identical or similar measures have a habit of fluctuating from one study to another. This is to be expected given the variations in sample characteristics and in the social and cultural factors that influence development, but it is a little more worrying when the correlations disappear altogether! What is certainly the case is that the prediction of an individual infant's current cognitive ability or future intellectual development is not yet possible.[11 29]

Although it may be possible to use measures of visual information processing to make predictions for groups of infants, the search must continue for a greater number of reliable measures of infant cognitive performance before a useful test of infant mental or cognitive development can emerge.

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Treatment of oesophageal varices

Bleeding from oesophageal varices is the most common cause of serious gastrointestinal haemorrhage in children. Bleeding may occur at any age, but some patients with varices never bleed.[1] The risk of bleeding is not linearly related to portal pressure, but to the size of the varix and the thickness and integrity of its wall.[2] Thus varices are most likely to bleed if they project prominently into the oesophageal lumen, if the overlying mucosa is blue, and particularly if there are 'cherry red spots' on the varix. Salicylate ingestion used to be recognised as an important precipitant.

The treatment of bleeding oesophageal varices is dependent on the underlying cause. In patients with portal hypertension from *intrahepatic* liver disease treatment is dictated by the latter and may determine the need for liver transplantation. Patients with good liver function and bleeding varices can, however, be successfully managed by treatment of their portal hypertension alone. Opinions on the primary management of *extrahepatic* portal hypertension have long been divided between those who advocate portosystemic shunting and those who favour endoscopic injection sclerotherapy. The results from studies of large series of children undergoing endoscopic injection sclerotherapy have encouraged the widespread acceptance of this technique in children with intrahepatic disease, in whom prognosis is determined more by underlying liver pathology, and in those with portal vein thrombosis or presinusoidal venous obstruction in whom variceal bleeding is the main threat to life.[3–5]

The management of acute variceal bleeding involves prompt but careful resuscitation. Shock should be corrected by cautious blood transfusion, but over transfusion may increase splanchnic blood flow and precipitate rebleeding. Coagulopathy and severe thrombocytopenia (platelet count less than 50×10^9/l) require correction and sepsis should be sought and treated with intravenous antibiotics. Patients must be monitored closely for continuing haemorrhage and the development of hepatic encephalopathy, and arrangements should be made for transfer to a centre where flexible fibreoptic endoscopy can be carried out by an operator skilled in injection sclerotherapy.

The use of somatostatin and its longer acting synthetic analogue octreotide has not been fully evaluated in children. In some adult studies these drugs have proved to be as effective as emergency sclerotherapy[6 7] and balloon tamponade[8] in controlling bleeding. Moreover, they are easily administered by continuous intravenous infusion and serious side effects are very rare. They may be particularly useful in stabilising a child before transfer or in preventing early rebleeding after sclerotherapy.[9] As they are not effective in non-variceal gastrointestinal bleeding,[10] diagnostic upper gastrointestinal endoscopy is essential.

Flexible fibreoptic endoscopy is ideally carried out under general anaesthesia with an endotracheal tube in situ within 24 hours of presentation. After assessment of the varices and the upper gastrointestinal tract, the varices are injected using a flexible endoscopic needle. Injections are concentrated at the cardia and in the lower 3 cm of the oesophagus (the site of perforating veins) and are predominantly intravariceal. The details of the technique and type of sclerosant have been reviewed elsewhere.[11] Patients are given ranitidine and sucralfate by mouth for up to two weeks after each injection session and antibiotic prophylaxis is recommended for those with damaged/prosthetic heart valves. The initial two or three treatments are performed at weekly intervals, but injection is deferred for one week if significant oesophageal mucosal ulceration is present. Further treatments are given at one to three monthly intervals until the varices have either disappeared or been converted into thrombosed cords. Most varices can be obliterated within one year by five to eight injection sessions.[3] Regular checks, usually as a day case, are then carried out every six to 18 months until a stable state is achieved.

The efficacy of sclerotherapy in treating oesophageal varices is clearly shown by the King's College Hospital series of 108 children treated in the 1980s.[3] Endoscopically confirmed obliteration of bleeding oesophageal varices was achieved in all children with portal vein obstruction and 84% of those with intrahepatic disease (for example, biliary atresia, congenital hepatic fibrosis, cystic fibrosis). All but one of the children whose varices were not obliterated did not complete a course of sclerotherapy because of liver transplantation or death from liver failure. Only one child died from variceal haemorrhage.

Injection sclerotherapy has been associated with numerous complications,[11] but these are rarely serious in children. Transient fever and mild retrosternal discomfort are common sequelae after injection and are usually self limiting, but may signify bacteraemia. Gastrointestinal bleeding before variceal obliteration is complete occurs in 40% of patients[3] and is usually due to a non-thrombosed varix or an oesophageal mucosal ulcer, but may be secondary to peptic ulceration. The short term incidence of recurrent oesophageal varices and bleeding from gastric varices is low (<10%) and the former often respond to further sclerotherapy.[3] In adults, sclerotherapy ulcers can be reduced by prophylactic ranitidine[12] and the incidence of oesophageal strictures can be decreased by using smaller