Behavioural disorders, impulsivity and violent behaviour

Attention deficit hyperactivity disorder (ADHD) is characterised by inattentive, impulsive and hyperactive behaviour occurring in children but some aspects of the condition may persist into adulthood (Richardson and Puri 2000, Richardson and Ross 2000, Arnold 2001). ADHD is a significant and increasing problem. It is estimated that it affects about 2% of school-aged children in the UK and 4% of school-aged children in the USA (Richardson and Puri 2000) and the use of medication to treat ADHD has increased dramatically in the last 10 years. Results of one study suggest that fish consumption may be associated with violent and impulsive behaviour (Hibbeln 2001). This cross-national survey of seafood consumption in 26 countries found that those with higher rates of seafood consumption tended to have lower rates of mortality due to homicide. The authors point out, however, there were many potentially confounding factors in this study and the hypothesis that fish consumption may help to reduce impulsive and violent behaviour should be tested in double-blind, placebo-controlled trials.

Boys aged 6-12 years with ADHD were found to have significantly lower plasma levels of AA, EPA and DHA compared to normal controls (Stevens, Zentall, Deck et al 1995). In a further study of boys of the same age, significantly greater scores indicating behaviour problems, temper tantrums and sleep problems were reported in subjects with lower plasma total n-3 fatty acid concentrations (Stevens, Zentall, Abate et al 1995). However, a double-blind placebo controlled trial of DHA supplementation (345 mg/day for 4 months) in children with ADHD found that DHA treatment did not decrease ADHD symptoms compared with placebo (Voigt, Llorente, Jensen et al 2001). The authors pointed out however, that lack of response to DHA supplementation did not necessarily mean that a low brain content of DHA is not involved in the aetiology of ADHD. It is possible that in the population studied, a benefit of DHA was not produced because other essential nutrients were also lacking.

It was suggested in recent reviews that ADHD may be linked to some other behavioural and neurological disorders, namely dyslexia, dyspraxia and autism, by an involvement of fatty acid metabolism (Richardson and Ross 2000; Bell, Sargent, Tocher et al 2000) and some studies of violent, impulsive and antisocial behaviour have also made this connection. Such behaviour has been linked to tissue deficiencies of n-3 fatty acids (Corrigan, Gray, Strathdee et al 1994; Stevens, Zentall , Deck et al 1995; Stevens, Zentall, Abate et al 1995; Hibbeln, Umhau, Linnoila et al 1998; Burgess, Stevens, Zhang et al 2000) and other nutrients including vitamins and minerals (Schoenthaler, Amos, Doraz et al 1997, Walsh, Isaacson, Rehman et al 1997). Virkkunen, Horrobin, Jenkins et al (1986) found that in a group of violent and impulsive offenders, plasma DHA was significantly lower than controls while n6 fatty acids were significantly elevated.

In a double-blind, placebo-controlled trial on young adult male prisoners, dietary supplementation with vitamins and minerals, as well as fish oil (80 mg per day EPA and 44 mg per day DHA) and evening primrose oil, resulted in 26% fewer disciplinary

offences in the supplemented group compared to placebo and 35% fewer disciplinary offences in the supplemented group compared to the baseline frequency (Gesch, Hammond, Hampson et al 2002). A recent double-blind placebo-controlled trial investigated the effects of dietary supplementation for 12 weeks with tuna oil (186 mg per day EPA, 480 mg per day DHA) and evening primrose oil in children with specific learning difficulties such as dyslexia (Richardson and Puri 2002). It was found that supplementation produced significant benefits. It has also been suggested that DHA in particular might be useful in treatment of dyslexia and dyspraxia as well as ADHD (Stordy 1995, 1997, 2000). Dyspraxia is a condition involving reduced motor skills manifesting as excessive clumsiness and there is a close link between dyspraxia and dyslexia (Stordy 1997). Stordy (1995) reported that, in a preliminary study, supplementation for one month with 480 mg per day DHA significantly improved an aspect of vision called dark adaptation in five dyslexic children. In a later open study of 15 children with dyspraxia, supplementation with the same dose of tuna oil and evening primrose oil as used in the study by Richardson and Puri (2002), produced significant improvements in scores for manual dexterity, ball skills and static and dynamic balance.

The studies described above, of impulsive and violent behaviour amongst prisoners and its possible association with PUFA status (Virkkunen, Horrobin, Jenkins et al 1986, Gesch, Hammond, Hampson et al 2002) may be compared to a series of studies of aggression in Japanese students. Hamazaki, Sawazaki, Itomura et al (1996) conducted a double-blind, placebo-controlled trial of fish oil supplementation (1.5-1.8 g DHA per day) and after three months of treatment, aggression scores were significantly lower in the DHA group compared to placebo. However, the reason for the difference was that aggression scores in the placebo group had increased while those in the DHA group did not change significantly. The difference was accounted for by the fact that the final assessment in the trial occurred just before academic examinations, which it was suggested had caused psychological stress. A similar trial was conducted on different students who did not face such stress and no significant change in hostility was recorded in the DHA or placebo group (Hamazaki, Sawazaki, Nagao et al 1998). The authors concluded that DHA administration could help to control aggression only at times of psychological stress (Hamazaki, Sawazaki, Itomura et al 2001). Hibbeln, Umhau, George et al (1997) pointed out that an apparent prevention of increased aggression is surprising because baseline intake of n-3 PUFA in the study population was relatively high. In a third double-blind, placebo-controlled trial on students. Plasma catecholamines were measured during a two-month period of continuous psychological stress due to university examinations (Sawazaki, Hamazaki, Yazawa et al 1999). In the DHA group, who took 1.5g DHA per day during the examination period, noradrenaline levels were significantly reduced. The authors interpreted this change as indicating that subjects in the DHA group adapted to stress more favourably than controls and that DHA may help to reduce the risk of stress-related diseases in individuals under long-lasting psychological stress (Hamazaki, Sawazaki, Nagasawa et al 1999, Hamazaki, Itomura, Sawazaki et al 2000).

In another study by the same group, Thai subjects aged 50-60 years, from a university and surrounding villages, were studied in a double-blind placebo-controlled trial in which the treatment was the same DHA supplement as used in the previous trials (Hamazaki, Thienprasert, Kheovichai et al 2002). DHA administration reduced aggression scores amongst university employees but not amongst village-dwellers. The authors speculated that the difference was caused by a larger placebo effect amongst villagers or a lower sensitivity amongst villagers to the psychological stressor (a video of stressful events) used in the study.

Conclusion

The epidemiological evidence that DHA-deficiency is a cause of violent and impulsive behaviour is supportive but not conclusive. Also, the few available studies of plasma fatty acids demonstrate lower DHA levels in individuals with ADHD. Data from supplementation studies are inconsistent but there are sufficient positive results to strengthen the view that DHA deficiency may be associated with adverse behavioural consequences.