# DYSLEXIA, DYSPRAXIA and ADHD - CAN NUTRITION HELP?

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## INTRODUCTION

There is a wide spectrum of conditions in which deficiencies of highly unsaturated fatty acids (HUFA) appear to play a role (Glen et al, 1999). This includes atopic (allergic) conditions such as eczema and asthma as well as psychiatric disorders such as schizophrenia and depression. The focus here is on the role of HUFA in three common learning and behavioural disorders - dyslexia, dyspraxia and attention-deficit / hyperactivity disorder (ADHD), although similar issues may also be relevant to the autistic spectrum (Richardson and Ross, 2000).

Dyslexia alone affects at least 5% of the general population in a severe form, as does ADHD, although estimates rise when milder forms are included. Dyspraxia remains less well-known, but prevalence appears to be similar. There is considerable overlap between dyslexia, dyspraxia and ADHD and each can occur with differing degrees of severity. Current evidence suggests that up to 20% of the population may be affected to at least some degree by one or more of these conditions. The associated difficulties usually persist into adulthood, causing serious problems not only for those affected, but also for society as a whole.

## DYSLEXIA, DYSPRAXIA and ADHD - CLINICAL FEATURES

The clinical overlap between these conditions is substantial: each can appear in isolation, but very often the same individual will show features of two, or even all three, of these disorders. Unfortunately, there is usually no such overlap in diagnosis and management. Official diagnosis of ADHD lies in the realm of psychiatry, with stimulant medication as the most likely treatment. Dyslexia is usually seen as an educational or psychological problem, and management is usually by these methods. Dyspraxia is the least recognised of the three, and if it is diagnosed at all, referral will often be to a physiotherapist or occupational therapist.

### Dyslexia

The defining feature here is specific problems in learning to read and write in relation to general ability or IQ, but problems with arithmetic and reading musical notation are also common. Poor working memory - especially for sequenced, auditory-linguistic material - is a central characteristic, and difficulties with phonology (the sounds in words) are often regarded as a core feature, although these are typically found in any poor readers. Associated features include problems in distinguishing left and right, poor direction sense, difficulties with time and tense, and subtle problems with both visual and auditory perception. The overlap with ADHD is around 30-50%, and with dyspraxia it may be even higher.

There is a clear biological basis to dyslexia. Genetic studies suggest heritability of around 50%, prevalence across cultures is similar (and independent of socio-economic status and IQ), and more males than females are affected. Differences in brain structure in dyslexia include an unusual symmetry of language areas and microscopic differences in the arrangement and connection of neurons. The visual and auditory problems point to a mild disorder of ‘magnocellular’ systems, specialised for very rapid information processing.

**Dyspraxia**

Core problems involve difficulties in planning and carrying out complex, sequenced actions. In motor co-ordination, this shows in clumsiness, difficulties with catching a ball or balancing, tying shoelaces or doing up buttons. However, dyspraxic children often have extremely poor handwriting, if not the other features of dyslexia, and difficulties with organisation, attention and concentration, as in ADHD, are very common. Dyspraxia is also associated with poor memory for symbolic material, both visual and auditory, and often with impulsivity and temper tantrums. These children can be hypersensitive to touch, smells and sounds, and they often prefer repetitive, familiar activities because they can find novel situations very stressful.

**ADHD**

The central problems here involve *Inattention*, i.e. persistent difficulties with sustained attention and concentration, and/or *Hyperactivity-Impulsivity*. Hyperactive-Impulsive children show excessive motor activity and restlessness, an inability to regulate behaviour according to the situation, and difficulty delaying gratification. Attentional problems are not always so obvious unless they occur together with hyperactivity, but these alone can create equally serious problems of under-achievement. A large proportion of ADHD children (around 50%) also show clinical features of dyslexia and/or dyspraxia, as noted above, although these associations are stronger for the Inattentive form of ADHD than for Hyperactivity-Impulsivity.

## ESSENTIAL LIPIDS AND BRAIN FUNCTION

To understand how fatty acid abnormalities could play a role in these conditions requires an appreciation of their essential role in brain structure and function. Two fatty acids (AA and DHA) play a major structural role in the brain and eye, making up 20% of the dry weight of the brain and more than 30% of the retina. Two others (EPA and DGLA) play a more minor structural role but are also crucial for normal brain function. EPA, DGLA and AA are all substrates for different series of prostaglandins and other molecules that play a critical role in the moment-by-moment regulation of a wide range of brain and body functions.

The truly essential fatty acids (EFA) which cannot be synthesised by the body and must therefore be provided in the diet are linoleic acid (omega-6 series) and alpha-linolenic acid (omega-3 series). The longer-chain highly unsaturated fatty acids (HUFA) that the brain needs can usually be synthesised from these EFA precursors via processes of desaturation (insertion of a double-bond) and elongation (adding two carbon atoms to the fatty acid chain).

**Pathways for the synthesis of omega-6 and omega-3 fatty acids**

| **Omega-6 Fatty Acids** | | ***Enzymes involved*** | **Omega-3 Fatty Acids** | |
|---|---|---|---|---|
| Linoleic (LA) | 18:2 | | Alpha-linolenic (ALA) | 18:3 |
| | | *Delta 6- desaturase* | | |
| Gamma-linolenic (GLA) | 18:3 | | Octadecatetraenoic | 18:4 |
| | | *Elongase* | | |
| **Dihomogamma-linolenic (DGLA)** | **20:3** | | Eicosatetraenoic | 20:4 |
| | | *Delta 5-desaturase* | | |
| **Arachidonic (AA)** | **20:4** | | **Eicosapentaenoic (EPA)** | **20:5** |
| | | *Elongase* | | |
| Adrenic | 22:4 | | Docosapentaenoic (DPA) | 22:5 |
| | | *Elongase, Delta 6-desaturase, Beta-oxidation* | | |
| Docosapentaenoic (DPA) | 22:5 | | **Docosahexaenoic (DHA)** | **22:6** |

Unfortunately, various dietary, lifestyle and disease factors can interfere with this conversion process. Dietary factors that can block the conversion of EFA to HUFA include: excess saturated fats, hydrogenated fats or 'trans'fatty acids in the diet (all of these are abundant in most processed foods); deficiency of vitamin and mineral co-factors (notably zinc deficiency), and excessive consumption of alcohol or coffee, as well as smoking. HUFA synthesis may also be impaired in people with diabetes, eczema, asthma or other allergic conditions. In addition, 'stress' hormones can also block the conversion of the 'parent' EFA into the longer-chain derivatives that are essential to the brain.

Thus many individuals may be deficient in HUFA despite the EFA precursors being available in their diet. Individuals will also differ in their constitutional ability to convert EFA to HUFA, and this is the suggestion in dyslexia, dyspraxia and ADHD, as well as some other disorders.

Overactivity of a PLA2 enzyme that selectively removes HUFA from membranes is another potential cause of fatty acid deficiency, and there is evidence for this in dyslexia (MacDonell et al, 2000). Other enzymes important in fatty acid recycling and transport could also be involved.

## FATTY ACID DEFICIENCY IN ADHD, DYSPRAXIA AND DYSLEXIA

### Evidence for fatty acid deficiency in ADHD

For a recent review of the current evidence for fatty acid abnormalities in ADHD, please see Richardson and Puri (2000). EFA deficiency in hyperactivity was first suggested by Colquhoun and Bunday (1981) of the Hyperactive Children's Support Group (HCSG) in the UK. They conducted a survey of hyperactive children and found the expected excess of males, associations with asthma, eczema and other allergic conditions, and evidence of zinc deficiency. They also noted various clinical signs of possible EFA deficiency in these children, including excessive thirst, frequent urination, and dry skin and hair.

They proposed that the problem might lie in the conversion of EFA to HUFA, because they saw no evidence of a dietary deficiency of the 'parent' EFA. They also hypothesised that this could explain both the sex ratio in ADHD (because males are more vulnerable than females to EFA deficiency) and the apparent intolerance of many ADHD children to certain foods such as salicylates (because these substances block the formation of prostaglandins from HUFA). The HCSG recommended supplementation with HUFA, and anecdotal evidence suggests that this was very helpful in at least some cases. Blood biochemical studies also provided some supporting evidence for deficiencies of certain fatty acids in ADHD (Mitchell et al., 1987)

Studies carried out at Purdue University in the USA provided further confirmation (Stevens et al, 1995, 1996). These showed that children with ADHD:

- were less likely to have been breastfed (breastmilk contains the preformed HUFA such as AA and DHA, while most formula does not)
- were more likely to suffer from allergies (already known to be associated with EFA deficiency)
- showed clinical signs of EFA deficiency (excessive thirst, frequent urination, rough dry skin and hair, soft or brittle nails etc)
- showed reduced levels in their blood of certain HUFA (especially AA, EPA and DHA) but not their EFA precursors.
- had an adequate dietary intake of the EFA precursors

These results support the hypothesis of EFA abnormalities in ADHD, and indicate that the problem could well be one of conversion of EFA to HUFA, as originally suggested.

This team gave an early report on results of double-blind treatment trials (Burgess, 1998). They found that supplementation with EPA, DHA, GLA and AA changed the blood fatty acid profile of ADHD

that supplementation with pure DHA was completely ineffective in ADHD another large controlled trial (Voigt et al, 1999). This is consistent with other evidence that EPA, rather than DHA is probably the important omega-3 fatty acid for management of the attentional, cognitive and other problems associated with ADHD.

**Evidence for fatty acid deficiency in Dyspraxia**

In children with dyspraxia, so far only open trials of fatty acid supplementation have been carried out (Stordy, 1997). 15 children whose performance on standardised measures of motor skills initially placed them in the bottom 1% of the population were treated with a supplement containing DHA, EPA, AA and DGLA. They were then retested after 12 weeks. After supplementation, improvements were found on objective measures of manual dexterity, ball skills, and static and dynamic balance, as well as on parental ratings of the children's dyspraxic symptoms. In addition, ADHD symptoms in these children (Conners Parent Rating Scale) were also reduced following the fatty acid treatment.

**Evidence for fatty acid deficiency in Dyslexia**

- ***Visual function in dyslexia improved by fatty acid treatment***

  Stordy (1995) proposed that fatty acid treatment may help in the management of dyslexia. She had first observed an apparent association between breastfeeding (and its duration) in relation to the severity of dyslexia, as well as poor night vision in dyslexic individuals. She therefore tested dyslexic adults and found they showed impaired dark adaptation, but this visual problem normalised after just 4 weeks of supplementation with the omega-3 fatty acids EPA and DHA.

  The role of omega-3 fatty acids in visual function is well recognised, and the evidence for visual problems in dyslexia is now substantial. Stordy's 1995 findings not only suggested a possible biochemical basis for these which might also help to explain other features of dyslexia, but also suggested new treatment possibilities.

- ***Abnormal brain lipid metabolism in dyslexia revealed by brain imaging***

  To investigate the proposal that membrane lipid metabolism in dyslexia may be abnormal, a study was carried out at the MRI Unit at Hammersmith Hospital (Richardson et al., 1997). MR imaging is a safe and non-invasive technique involving the use of radiowaves within a very strong magnetic field. It can be used to obtain either structural images (the well-known MRI) or information on the chemical composition of tissues (magnetic resonance spectroscopy, or MRS). To study membrane lipid metabolism in the living brain, 31-phosphorus MRS is the best available technique. From 31-phosphorus MRS spectra, seven different phosphorus metabolites can be clearly identified, and their concentrations measured. Two of these provide information on membrane lipid turnover: *phosphomonoesters* (PMEs) include the precursors of membrane phospholipids, while *phosphodiesters* (PDEs) index their breakdown products.

  Results showed a clear excess of PMEs in dyslexic adults compared with controls, suggesting a problem in the synthesis of membrane phospholipids in dyslexia, while PDE levels were normal. These results are also compatible with deficiency in certain HUFA in dyslexia. (PMEs have to combine with diacylglycerols - molecules with two fatty acids - to form membrane phospholipids. If these molecules do not contain the 'right' fatty acids, then this process could be impaired, resulting in an accumulation of the PME precursors.)

- ***Blood biochemical abnormalities in dyslexia***

  In a single case report, Baker (1985) found fatty acid deficiencies on biochemical testing of a dyslexic boy who also showed overt clinical signs such as rough, dry skin and hair. More recently, MacDonell et al (2000) found that dyslexic adults showed increased levels of a PLA2 enzyme that removes HUFA from membranes.

- ***Clinical signs of fatty acid deficiency in dyslexia***

  In a large sample of dyslexic and non-dyslexic adults, clinical signs of fatty acid deficiency were significantly higher in the dyslexic group (Taylor et al., 2000). These signs were assessed using the same scale as was used in recent studies of ADHD (Stevens et al., 1995), where fatty acid

deficiency scores were also related to blood biochemical measures of fatty acid deficiency. Within dyslexic children, those with more clinical signs of fatty acid deficiency had more severe difficulties in reading, spelling and working memory (Richardson et al, 2000). However, there was no evidence that fatty acid deficiency was confined to any particular subgroup as defined by psychometric tests.

· ***Double-blind treatment trials in dyslexia - preliminary results***

In view of the mounting evidence for fatty acid abnormalities in dyslexia, several double-blind clinical trials were set up to assess whether treatment with fatty acids can be of benefit in this condition (Richardson et al, 1999). These studies are now approaching completion, and some preliminary results are already available.

**Trial 1**: In a school-based study, 41 dyslexic children with ADHD features took either a fatty acid supplement (mainly fish oil with some evening primrose, supplying EPA, DHA, GLA and some AA) or a placebo (containing olive oil) for three months. They were assessed before and after treatment on standard parent ratings of ADHD symptoms (Richardson et al, 2000).

- Compared with the placebo-treated group, those dyslexic children who had received the fatty acid supplement showed significant reductions in a range of ADHD symptoms, particularly cognitive problems (inattention, learning and memory problems) and anxiety.
- In a second stage of the study, those children who had received the placebo treatment were then switched to the fatty acid supplement under single-blind conditions and followed for a further 3 months. In these children, significant improvements were observed for a wide range of ADHD measures, in striking contrast to the lack of improvement they had shown on placebo treatment.

Numbers in this study were small, so these results need to be confirmed in larger double-blind trials still underway. However, they provide promising evidence that dietary supplementation with HUFA can be of some benefit in the management of ADHD-related symptoms in dyslexia.

**Trial 2:** In a larger clinic-based study, 102 dyslexic children took either the same fatty acid supplement or placebo for six months under double-blind conditions. Supplementation was associated with significant improvements in reading, especially for children with fatty acid deficiency signs or visual symptoms at baseline.

## FREQUENTLY ASKED QUESTIONS

### *1. Is fatty acid deficiency more likely in ADHD, dyslexia,or dyspraxia?*

In my view, these kinds of diagnostic labels should usually be treated with more than a degree of caution. There is huge variability in both access to formal assessments and the diagnostic methods used. All of these conditions exist in graded form, with core features often blending imperceptibly into the general population range. More importantly, perhaps, the overlap between these conditions in practice is so great that so-called ‘pure cases’ are the exception rather than the rule.

Research suggests that a significant proportion of people with any or all of these conditions (and some others with no such official label) could be helped by simple dietary supplementation with highly unsaturated fatty acids. However, it must be emphasised that:

(i) this approach can’t be expected to benefit every individual with dyslexia, dyspraxia or ADHD – simply because the causes of these kinds of problems can be so varied, and

(ii) although good nutrition is the foundation for optimal brain function, many other factors obviously need to be considered in the management of these conditions.

Our treatment trials have involved children and adults identified primarily for either dyslexia or ADHD. However, we have taken care to assess features of all three conditions as far as possible. (For the record, more than half of our dyslexic and ADHD children met clinical criteria for dyspraxia, and we found the usual high overlap between dyslexia and ADHD in both children and adults). In our adult study, we also included a non-dyslexic group, and we assessed them using the same measures, as there is already some evidence of benefits from HUFA supplementation in the general population

## 2. *How can we best identify people who can be helped by fatty acid supplements?*

Clearly, supplementation is most likely to help if there is already some evidence of a relative deficiency in highly unsaturated fatty acids. Unfortunately, objective biochemical measures of fatty acid status are not usually a practical option. Our research aims include the development and validation of some simple, non-invasive measures that might be suitable for routine clinical use. Meanwhile, the following provide some provisional guidelines for identifying those who may be most likely to benefit from fatty acid supplements.

· **Physical signs of fatty acid deficiency**

Various physical signs are associated with essential fatty acid deficiency – and although all of them could have other causes (and if persistent, should be discussed with the GP to rule out any overt medical problems), their presence provides reasonable grounds for suspicion. These 'fatty acid deficiency signs' include excessive thirst, frequent urination, or rough, dry patches on the skin - especially if this is 'bumpy' in appearance and feel (this is 'follicular keratosis', and is usually most noticeable on upper arms and legs). More minor indicators include dull or dry hair, tendencies to dandruff, and soft or brittle nails. These signs are more common in individuals with ADHD or dyslexia than they are in the general population, and their presence – while not definitive – might suggest a positive response to supplementation.

· **Atopic (allergic) tendencies**

Tendencies towards certain allergic (or 'atopic') conditions such as eczema, asthma or hay fever seem to be more common in people with dyslexia or ADHD and their relatives. Fatty acid deficiencies can play a role in these allergic conditions, and supplementation with fish oils and/or evening primrose oil can often help to relieve some of their symptoms.

· **Visual perceptual problems**.

From our clinical experience (and preliminary results from our treatment studies of dyslexic children) visual perceptual problems seem to be a good predictor of a positive response to HUFA supplementation. Despite having no 'overt' visual problems that an ordinary eye test would detect, many dyslexic people report visual symptoms when trying to read, such as blurring or apparent movement of letters and words, eye strain, or 'glare' from text on the page. Other visual problems include unusual sensitivity to bright light in general, poor night vision, and broader difficulties with visual attention and visuo-motor control. These features are common in dyslexia and dyspraxia, and affect at least some individuals with ADHD. Given the importance of omega-3 fatty acids in visual function, it is perhaps not surprising that visual problems may help to predict those who respond well to supplementation.

· **Attention and concentration problems**

A good response to HUFA supplementation seems more likely if there are genuine problems with attention and concentration. Many children (and adults) find that 'distractibility' is a major problem – they have real difficulties in 'screening out' things that are irrelevant to the task in hand. Or they find that their minds are prone to 'wander' even without obvious distractions, and so they have to make extraordinary efforts to focus their attention for any length of time - often with the result that they tire very easily. Preliminary evidence from our studies suggests that fatty acid supplements can help to improve attention and concentration in many dyslexic children with these features. This criterion obviously includes others who show a pure ADD profile, as well as ADHD children with a mixed picture of inattention with hyperactivity-impulsivity. (Less success might be expected for those with pure hyperactivity-impulsivity, let alone 'conduct disorder' as the primary problem). Attentional problems are also very commonly associated with dyspraxia.

· **Mood swings / undue anxiety / low 'frustration tolerance'**

Emotional sensitivity – especially when accompanied by a proneness to 'mood swings' - and anxiety / tension may also be good predictors of a beneficial response to omega-3 HUFA supplementation. Some individuals are particularly susceptible to stress or criticism (real or perceived), and they take

any ‘failure’ very much to heart. Omega-3 supplementation has been shown to reduce susceptibility to stress-aggression in ordinary students under pressure. Results from our studies also suggest a good response to fatty acid supplements by those with a very low tolerance for frustration, i.e. those who are prone to either emotional outbursts or undue anxiety-tension when things don’t go as planned. It is noteworthy that omega-3 deficiencies are implicated in mood disorders, both depressive and bipolar (manic-depressive). Children with these traits often meet criteria for ADHD, and may perhaps represent a subgroup who would respond well to fatty acid supplementation, although this too requires further study.

· **Sleep problems**

Certain HUFA are required for the manufacture of prostaglandins, and among many other functions, these molecules play an important part in determining sleep onset and offset. Fatty acid imbalances could therefore be a factor in some kinds of sleeping problems, and research evidence supports this, although few if any clinical studies have yet been carried out. Subjective reports from participants in our treatment trials strongly suggest that fatty acid supplementation may help to improve sleep for some people, particularly if difficulties in getting to sleep at night (and corresponding difficulties waking up in the morning) were previously characteristic. Perhaps unsurprisingly, those who respond to supplementation in this way usually report other benefits. These may all be a consequence of the improvements in sleep, or they may represent other effects of fatty acid supplementation in these individuals. In either case, this issue clearly deserves further study.

***3. What kind of supplements will work best?***

First, it should be re-emphasised that fatty acid supplements will not ‘work’ for everyone. Some people already get all the HUFA they need via their diet and/or their own metabolism. Individual differences in constitution, diet and lifestyle are all important, so there can be no universal answers. However, the following points may help to provide some guidance for those interested in trying supplementation.

**Omega-3 fatty acids** play a crucial role in eye and brain function, yet these are the ones most likely to be lacking from modern diets. In theory, we can build complex fatty acids for ourselves from simpler ones. However, even the simple omega-3 fatty acids are lacking in many people’s diets (particularly if they mainly eat processed foods), and in some people, the conversion process of simple fatty acids into the longer-chain, highly unsaturated ones may be inefficient. The only way to get the complex omega-3 fatty acids (EPA and DHA) directly from the diet is by consuming large amounts of oily fish and seafood on a regular basis. This is often impractical, so fish or marine oil supplements are sometimes the only realistic option.

**Omega-6 fatty acids** are also important, with evening primrose oil being the best-known supplement source. Evening primrose alone often helps with the dry skin problems and allergies common in people with ADHD, dyslexia and dyspraxia (and often found in their relatives). However, early studies using evening primrose oil alone showed only marginal benefits, if any, for the central problems with learning and behaviour. For brain function, the omega-3 fatty acids seem to be more important, but these are less common in our food supply than omega-6.

In most cases it therefore probably makes sense to supplement mainly with fish oil (providing the omega-3 HUFA) but many people may benefit from a little evening primrose oil in addition.

**Omega 3: EPA versus DHA?** Fish oil contains two major omega-3 fatty acids: EPA and DHA. Both are necessary, but until recently, it wasn’t at all clear which of these was more important in producing the benefits reported for ADHD and related conditions. In early life, plenty of DHA is needed for the growing brain – and because this fatty acid is so important for actual brain structure, it was thought that this must be reason for the apparent benefits from fish oil. However, the latest research has now shown that it is EPA, not DHA, which is more effective in reducing the problems with attention, perception and memory that are associated with ADHD, dyslexia and dyspraxia. This is probably because EPA plays a more important role in the minute-by-minute functioning of the brain, and also helps to make other substances (such as prostaglandins) that are crucial for proper signalling between

cells. In addition, new evidence suggests that EPA may actually help in another way – by helping to protect all of the long-chain highly unsaturated fatty acids against rapid breakdown and loss. For these reasons, supplements with a high ratio of EPA to DHA are likely to be most effective.

A note of caution should also be sounded about cod-liver oil – or any fish liver oil – for these purposes. These do provide an excellent source of omega-3 fatty acids for general use, but they also contain significant levels of Vitamin A, which can be harmful in excess. One or two capsules a day should present no problems, but if high doses of fish oil are to be taken on a regular basis, the fish liver oils are probably best avoided.

A final point concerns the quality of oils used. The popularity of both evening primrose and fish oils has led to a huge number of different supplements becoming available. Unfortunately, not all of these are of good quality, and in some cases, they may not only be ineffective, but could even contain harmful residues (either from environmental pollution or from the methods of extraction and processing used). Any reputable supplier should be able to provide information on both the source of their oils and their manufacturing methods, but at the very least, it should not be assumed that the cheapest supplements are the best value. Another point is that Vitamin E is usually included in HUFA supplements as an antioxidant to protect these fatty acids from breakdown. If it is not, additional Vitamin E supplementation may be required.

***4. Are there any negative side-effects from fatty acid supplements? What dosage is appropriate?***

Highly unsaturated fatty acids are safe even in extremely large doses, and their regular consumption carries a wide range of positive health benefits. They are foodstuffs, not drugs – and moreover, they used to form an important part of our natural diet for centuries, but have been disappearing from our food in recent decades. The only known side-effects of fatty acid supplements involve mild digestive upset, although this affects very few people. Small divided doses taken with plenty of food can often eliminate such problems (and it is worth noting that choosing a high-quality oil should also help to reduce any fishy aftertastes!).

The appropriate dosage will vary between individuals (and in the same individual over time). It is also very important to recognise that it can sometimes take up to three months for the maximum benefits from supplementation to become apparent, owing to the slow turnover of these fatty acids in the brain. Unlike medications, they do not work rapidly to change mental functioning, and although we have found that some individuals report clear benefits as rapidly as two weeks after starting supplementation, in other cases the changes are much more gradual.

A higher dose is therefore usually recommended for this ‘trial period’. An initial dosage of fish oil supplying around 500mg daily of EPA is probably most appropriate for dyslexia and related conditions, and if evening primrose is also included, around 50mg per day of GLA (which converts easily to DGLA and AA) is likely to be sufficient. After three months, reducing the dose to half or one-third of these levels may be appropriate, but requirements vary – both between individuals and according to circumstances - so dosages are best determined from experience and careful personal monitoring. We have found that some people may need high levels on a long-term basis to prevent symptoms from re-appearing.

Informing the GP is strongly recommended before embarking on any kind of dietary supplementation, and this is obviously essential if someone is already taking any medications or being treated for any other condition.

As emphasised throughout, not everyone can expect noticeable benefits from taking fatty acid supplements. If no improvements are apparent within three months of starting this kind of dietary treatment, then it is reasonable to conclude that fatty acid deficiency is not a major factor for that individual. Other approaches to managing dyslexia, dyspraxia and ADHD should always be considered in any case.

## CONCLUSIONS

- The available evidence supports the proposal that a mild disorder of fatty acid metabolism may be a factor predisposing to dyslexia, dyspraxia and ADHD, and this could go some way towards explaining the strong associations between these conditions. However, there are considerable individual differences amongst people identified by any of these labels, and each of these 'conditions' can have many possible causes. Fatty acid deficiency is only one possibility, and many other factors are likely to interact with this.

- Relevant fatty acid abnormalities that would increase dietary requirements include:
  (i) difficulties in the conversion of simple essential fatty acids (EFA) into their longer-chain derivatives (HUFA) that the brain needs, such as DGLA, AA, EPA and DHA
  (ii) excessive breakdown of these HUFA (e.g. by overactive PLA2 enzymes)
  (iii) difficulties in recycling, transport or incorporation of HUFA into membranes.

- Direct supplementation with HUFA may therefore be of benefit in the management of these conditions. Controlled trials have provided preliminary evidence for this in both ADHD and dyslexia, although more large-scale clinical treatment trials are needed. Findings suggest greater benefits from omega-3 fatty acids, and particularly EPA.

- Fatty acid supplements obviously cannot be expected to help in every case, but potential indicators of a good response to supplementation include:
  - *Physical signs of fatty acid deficiency* (excessive thirst, frequent urination, rough or dry skin and hair, dandruff, and soft or brittle nails)
  - *Allergic tendencies* (especially eczema)
  - *Visual symptoms* (such as poor night vision or sensitivity to bright light, and visual disturbances when reading - e.g. letters and words move, swim or blur on the page)
  - *Attentional problems* (distractibility, poor concentration and working memory)
  - *Emotional sensitivity* (especially excessive mood swings or undue anxiety)
  - *Sleep problems* (especially difficulties in settling at night and waking in the morning)

  Ongoing research will help to clarify the relative importance of these features as indicators of relative HUFA deficiency. Although common in ADHD, dyslexia or dyspraxia, they are certainly not confined to individuals with these conditions.

**Further reading***


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· Smart fats. Michael Schmidt, 1997. North Atlantic Books, California.
· The LCP Solution – the remarkable nutritional treatment for ADHD, Dyslexia and Dyspraxia. B. Jacqueline Stordy and Malcolm J. Nicholl, 2000, Ballantyne Books: New York.


The books listed here are for general reading, and can all be ordered from the website of the Dyslexia Research Trust, at www.dyslexic.org.uk

Academic references cited in this text are provided below


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