

The Dyspraxia Foundation Professional Journal

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What Happens to Children with D.C.D. When They Grow Up?

By

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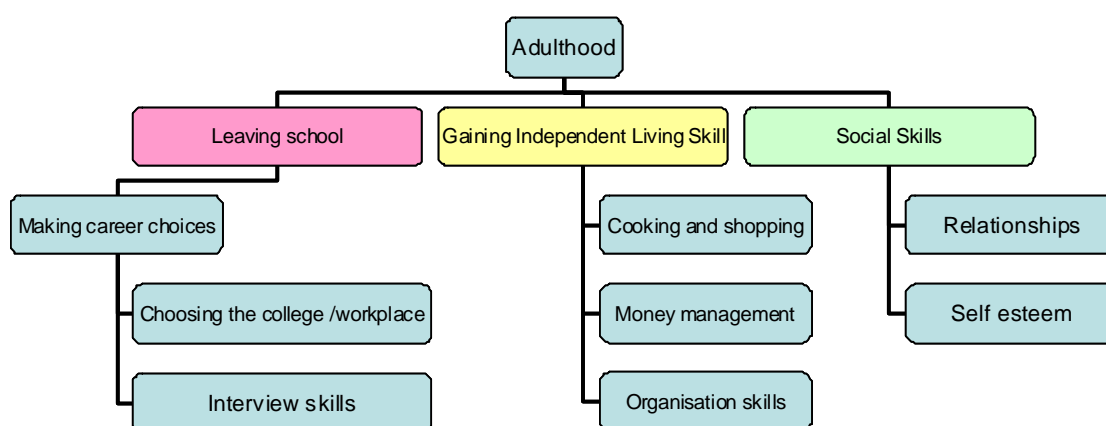
Introduction

In the past few years there has been increased recognition of DCD. The development of organisations such as the Adult Dyspraxia Groups in the UK has an acknowledgement that children grow up and raises the question of the types of difficulties that remain a problem into adulthood and what are the long term outcomes. This is in comparison with other specific learning difficulties such as Dyslexia and ADHD, where greater volumes of research have been undertaken. Certainly in these conditions there has been noted that difficulties remaining often relate to social, emotional and behavioural difficulties¹ and the initial difficulty, for example literacy, is less of the problem.

If we are to ensure that there is appropriate support in colleges and in the workplace for individuals with DCD, then there needs to be a greater awareness of the types of difficulties and an idea of the type of support that may need to be put in place.

Most colleges have not yet come to grips with what it means to have students with specific learning difficulties in terms of teaching, academic evaluation, diagnosis, and counselling. In light of both equal opportunity and disability discrimination laws, the need to recognise and support individuals with specific learning difficulties, especially those with DCD is essential. If not addressed then this can profoundly affect a person's educational and psychosocial development.²

This article considers current knowledge of the potential outcome for adults with DCD compared with other groups that have been researched more fully and speculates on some difficulties that have been observed that require further research.



What areas may need to be addressed?

Leaving the formal and structured environment of school and having greater choices about further education may feel both liberating and scary. For many years the individual with DCD may have felt like a round sausage in a square sausage machine never quite fitting in. For the first time some of the barriers to effective learning have been removed and choices how to live and what career to choose become realities. However change in the past may have caused stress and anxiety and this now may again be an issue in adapting and moving through this transition stage successfully.

Attitudes by others who may come into contact with the adult may impact on where he goes for help. His first experience may be being asked to fill in a form when he knows his writing may be illegible and be misjudged. Careers advisors in South Wales were recently surveyed after receiving training about DCD, and were found to have had a low level of understanding of the difficulties that individuals may portray. Careers advisors are often the first port of call for advice in school. However, if there is a lack of training then the advice given may not be appropriate at this early stage. One other port of call will be the Disability Employment Advisor (DEA) in the Job Centre. DEAs' do not receive any formal training in DCD, and may not recognise that the individual even has a problem in the first place and may assume someone who shows reluctance, and anxiety to not want to try and new job. Occupational Psychologists have undergone formal training in the past 2 years by The Dyscovery Centre and there is some evidence to show that this has had some impact on the type of advice and quality of advice given to individuals

For many, school days may have been the worst and it is only after leaving school that there is the awakening of potential skills. However for some, the low self esteem and feelings of self worth can also develop into depressive symptoms and may require specialist treatment. Young people with DCD, both male and female, may have become clinically depressed in adolescence and have been shown to be at significantly increased risk of later major depression, anxiety disorders, nicotine dependence, alcohol abuse or dependence, suicide attempt, educational underachievement, unemployment, and early parenthood.³

In comparison, research with adults with ADHD have been shown to display greater self-reported psychological maladjustment, more driving risks (speeding offences), and more frequent changes in employment. Significantly more ADHD adults had experienced a suspension of their driver license, had performed poorly, quit, or been fired from their job, and had a history of poorer educational performance and more frequent school disciplinary actions against them than adults without ADHD⁴. There is a need to compare individuals with DCD to see if similar outcomes occur. As we know there is a level of co-morbidity with DCD and ADHD in 50% of individuals⁵

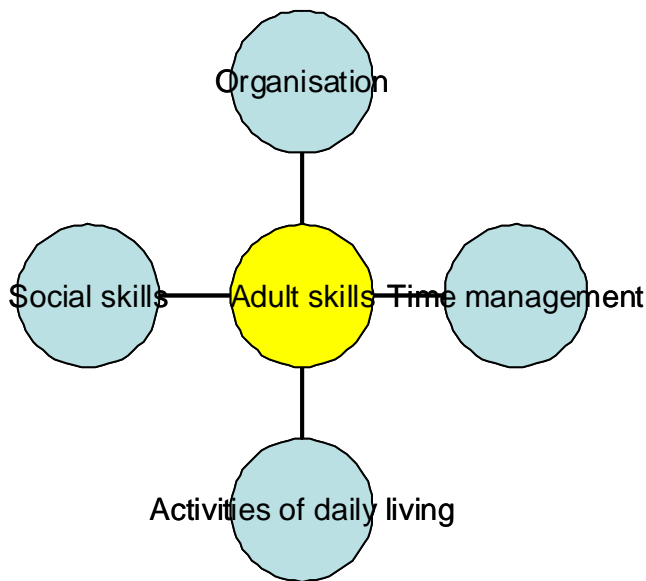
Certainly Gillberg and co-researchers have shown that in the ADHD/DCD group, 58% had a poor outcome compared with 13% in their comparison group ($p < .001$). Remaining symptoms of ADHD, antisocial personality disorder, alcohol abuse, criminal offending, reading disorders, and low educational level were overrepresented in the ADHD/DCD groups and the co-existence of both conditions together has a gloomier prognosis⁶

Certainly at a practical level learning to drive a manual car and parking the car seem to be difficulties for many adults with DCD. However there is little or no research considering if the individual with DCD has more accidents. Certainly individuals with Dyslexia have been shown not to recognise traffic signals in comparison with the general population⁷

Getting into employment may be a difficulty with adults with DCD who may not have the skills to interview well, but sustaining a job may actually be a greater difficulty, where a changing environment is hard to cope with. Coping with peers and a boss and responding to tasks at speed may be too difficult without more support. The degree of difficulties in adult life will vary enormously from one individual to another. Some of the areas of difficulty may be minor and relatively easily remediable such as food preparation in the kitchen, whereas others such as socialising and sustaining friendships may remain a problem that continues throughout adulthood. In the USA and Canada DCD like difficulties are sometimes known as non verbal learning

difficulties and the same conclusions have been met that concentrating on social skills as an outcome is important⁸

However there are some general skills that we all need to acquire to be active and successful adults and are usually the areas that most commonly remain a difficulty for the adult with DCD.



Successful transition from school into the workplace means that appropriate multi-disciplinary working occurs between different agencies. There needs to be good transfer of information as well as on- going inter-agency communication. Historically this has been poor in not just supporting individuals with DCD but in the provision of services in areas such as Occupational Therapy and mental health services. The concept of Transdisciplinary working where there is client involvement remains poor⁹. Transdisciplinary working is where agencies work together with a primary worker for each client may allow a better model of practice for the adult. This has been used with a project in South Wales, called the BOLD project (Borderline Learning Difficulties) where a key liaison person working with others on a consultancy basis seek out and co-ordinated the best management plan for the adult. Use of a “share care organiser”, which is a personalised portfolio which contains the relevant information on the client from the present and the past, has also allowed health, educational and social service information to be collated and held with the individual. The key worker system allows for transfer and collation of information to be done in a logical manner and reduces the need for several agencies to collect the same information. This has both a positive implications of reducing time and consequently cost for the client and the providers working with him.

There is still a great deal of work required in considering who needs to be a part of the support team and how inter-agency working can be most affective for the individual with DCD¹⁰

Psychological consequences

Individuals with more severe difficulties may show symptoms of depression and feeling chronically anxious. Depression may present as low self esteem, feelings of worthlessness, sleep disturbance, difficulty with concentrating and appetite disturbance. These symptoms should be treated in a traditional way using medication or approaches such as cognitive behavioural therapy. It is not known if there is a direct link with DCD and depression but there may be similar root cause to both conditions. Interestingly enough an Israeli group of researchers have shown the improvement of depression taking omega-3 fatty acid supplementation. This could be further evidence to support the link between the two disorders and an additional approach to treating some individuals with DCD.¹¹

Negative behaviour that was first seen in some adolescents with DCD may escalate in adulthood into increasingly negative social behaviour, ending up in being caught in the penal system. Studies have shown that there are a greater percentage of individuals with specific learning difficulties in the prison population, some of whom have not been clearly identified in school days as having a specific learning difficulty.¹² A recent study in a Scottish prison showed the level of Dyslexia was as high as 50%.¹³ This may be an effect of social drift, where there has been a lower level of academic achievement and fewer chances of job success.

Co-ordination difficulties

There is some evidence to show that co-ordination difficulties do remain for a proportion of individuals with DCD. Tasks requiring fine motor co-ordination such as threading a button, using a can opener, or cutting with a pair of scissors may remain difficult.

Gross motor difficulties such as playing sports may be less of a problem as the individual no longer has to be competitive and can participate for pleasure. He is not being measured against other people's performance.¹⁴

Long-term implications of poor stability in hips and shoulders in some adults and therefore adaptive postures to maintain stability, may lead the adult to have tight "hamstring" muscles and tight Achilles tendons. The adult may also have back pain because of years of adapting their posture to cope with their co-ordination difficulties. They may have had to cope with chronic back pain because of hypermobility of their joints¹⁵. This may have a psychological affect as well as a physical one. Even headaches caused by temporomandibular dysfunction may be occurring in individuals where there has been ligamentous laxity around the jaw.¹⁶

Conclusions:

There is little research into the long term outlook for adults and this needs to be addressed¹⁷ Certainly there is some evidence to show a link with gross motor difficulties in children and an increased risk of schizophrenia in adults.¹⁸ This has to be balanced by early screening and recognition to ensure support to limit the long term psychological and functional consequences. This has a cost to society in reducing the ability of individuals to work. There may be a revolving door scenario occurring where individuals get in to work and lose jobs, and this has an additional impact on their health and self esteem. If we are to plan and provide a comprehensive service that allows individuals with DCD to fulfil their potential, we must gain an understanding of the core difficulties.

The Foundations for Success

Staying in the job
Adapting to change
Living independently
Maintaining relationships

Starting a job
Learning the day, learning the rules
Making new friends
Learning the job
Travel to the job

Time management
Planning a job
Needing specialised or adapted equipment

Interview techniques
Application forms
Disclosure
Attending training courses
Tool kit for interview

HOME

Environment
Organisation
Getting up, dressing appropriately,
Making a snack
Planning a day

SKILLS

Managing money
Using public transport
Navigating new environments
DIY/computer
Shopping and planning

PSYCHO-SOCIAL

Social skills
Judgement
Self esteem
Maturity
Sexuality
Making a relationship with same and opposite sex

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A Three Year Study on the Progress of Children Following Physiotherapy Treatment for Dyspraxia

By

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Abstract

Following a study of 60 children with Dyspraxia by Lee & Smith in 1998, the original authors were keen to ascertain whether the improvement that had been reported at that time had been maintained up to 3 years post physiotherapy. Results from this new study showed that 33 out of the 60 children had continued to attend for reviews. Twelve (12) out of the total of 60 had required further courses of treatment and had shown that after this, they and all of the children who had continued to be reviewed, had maintained and in many cases improved upon the scores with their gross motor skills. The scores that had been taken in the original study and at their review, were compared to the results taken at a further assessment for this new study. In addition, a questionnaire was sent to all of the parents of the 60 children who had been included in the original study and 53 (88%) of these were returned. Findings from the questionnaire revealed that parents were very positive about their children's progress, especially in relation to the gross motor abilities, self confidence and social skills. However, some concerns remained with the school work especially, mathematics, writing and short term memory.

This subject group will continue to be monitored and it is hoped that more long term data will be obtained and published. The aim being to confirm that, in the long term, physiotherapy is and remains an extremely effective form of treatment for Dyspraxia.

Introduction

In 1998 Lee & Smith indicated that physiotherapy was effective in the treatment of Dyspraxia. In a study of 60 patients, each one receiving an 8 week course of physiotherapy treatment, comparative results at the end of the programme and again 3 months later revealed mean improvements of 69% and 73% per child respectively. The study also confirmed that the parents considered that their children had achieved a mean improvement of 72% per child in their associated daily living activities.

The authors suggested that the study should be followed up in order to monitor the long term effects and benefits of the treatment. This was also considered to be particularly important as there had been no reported long term studies of children following treatment. The areas to be specifically monitored were considered to be:

- how many children had required further courses of treatment.
- how the children were presently coping in school, both academically and with sports.
- whether the improved self confidence and self esteem reported after the initial treatment had been maintained.
- how successful the parents and their children had considered the long term management programme to be
- the reasons why some children had not returned for annual reviews.

Methodology

Subjects

All children from the original study (60 in total) were recommended to be reviewed annually. Thirty three (33) parents elected to have their child reviewed but 27 did not. Initially the consent for taking part in the study had been given by the parents. At that time parents had also given consent for their children to be included in further studies up to 10 years following the initial study.

Tests and Measurements

The 33 children who returned for annual review were assessed using exactly the same assessment procedures as described in the original paper.(Lee & Smith, 1998). This had included using the objective tests used in the outcome measures. The skills tested were:

* active trunk extension	* pelvic control
* active trunk flexion	* shoulder control
* bilateral integration	* proximal stability
* eye hand co-ordination	* eye foot co-ordination
* motor planning and self organisational skills	* short term visual and verbal memory
* symmetrical integration	* spatial awareness

In addition, the assessment included the following tests but these areas did not form part of the outcome measures:

* muscle tone	* full range of passive movement of all joints
* directional awareness	* right and left side discrimination
* body perception and proprioception	* ability to cross midline
* kinaesthetic awareness	

Procedure

All of the children who returned for annual reviews were assessed and the test scores from the outcome measures were compared to those from their previous review. In addition, a simple questionnaire (Appendix A) was used for the parents to complete to determine opinions on their childrens' improvement.

For the 33 patients who continued to be reviewed annually, each parent and child was asked to complete the questionnaire at the time of their annual review. Questions 4 and 5 (see Appendix A), which related to the reasons for not returning for annual reviews, were not completed by this group.

The questionnaires were also sent to the 27 families whose children had not returned for annual reviews. A stamped addressed envelope was enclosed to encourage return. Of the 27 sent out, 20 families returned this questionnaire.

Results

A total of 33 children were reviewed.

Table 1 - Results of the reviews

33 children were reviewed annually

Progress recorded in first year:

- 4 children were required to receive further courses of treatment. At the review 3 months following the additional treatment all had improved their scores
- 23 children had maintained their scores from the previous year
- 6 children had improved upon their scores. These improvements were noted in proximal stability and ball skills

Progress recorded in second year:

- the 4 children who had received treatment the year before were noted to have maintained their improved scores from their previous review
- 4 children were noted to have dropped their scores in the following areas:
 - 2 with shoulder control, pelvic control and eye hand co-ordination. One of these received a further course of treatment by the first author and the second patient was given a few exercises and activities to complete at home
 - 1 had difficulty with writing skills. This patient was referred to their local occupational therapy department
 - 1 had problems with short term memory. A few activities were given to the parents
- 14 children had maintained their scores from the previous year
- 11 children were noted to have improved their scores in all areas, but in particular with short term memory, self organisational skills and ball skills.

Progress recorded in third year:

- the 4 children who had reported difficulties the previous year, were noted to have improved their scores and eliminated (most of or all of) their difficulties.
- 15 children were noted to have maintained their scores from the previous year
- 14 children were noted to have improved their skills in the following areas:
 - short term memory
 - proximal stability (shoulder and pelvic control)
 - ball skills
 - self organisational skills

A total of 53 questionnaires were completed

Table 2 Results from the Questionnaires

60 questionnaires distributed. 53 returned (88%)

Question	yes (out of 53)	no (out of 53)
Are you happy with your child's progress?	50	3
Do you have any concerns about your child's progress?	19	34
If yes, is this related to: school work?	19	0
Physical abilities?	3	16
Is your child happy with their progress?	51	2
Has the self confidence and self esteem remained good?	51	2
Have you continued to come for annual reviews?	33	20
If "no" is this due to: contentment with your child's progress	14	0
other reasons	6	0
Has your child required a further course of treatment after the initial programme?	12 <i>(includes 4 who were discussed in the original programme)</i>	41

Was this additional treatment helpful?	9	3
Do you carry out the monthly checklist given to you at your last review?	27 (+ 8 reported occasionally)	18
Does your child participate in additional sports/activities/hobbies as recommended?	51	2

1. The following is a list of the main concerns raised by parents about their child's progress extrapolated from the responses:

- Poor at mathematics
- Resistance to carrying out homework
- Very emotional with the child having difficulty in controlling it
- Concern that the child would not be able to keep up in examination situations
- slow writing
- Poor organisational skills e.g. getting materials ready for lessons, writing essays
- Poor short term memory
- Poor spelling and reading

2. Of the 33 children who had continued to return for annual reviews.

- Ten (10) had returned each year for 3 years
- Twelve (12) had returned each year for 2 years
- Eleven (11) had returned for 1 year. However, these had only completed the programme up to 1 year ago

3. The 20 parents who had not brought their children for reviews gave the following reasons:

- *"We were happy with our child's progress and did not consider it necessary"* - 9 parents
- *"Physiotherapy is now provided our local physiotherapy department"* - 3 parents
- *"Our fault, despite being reminded, we never seemed to have the time"* - 5 parents
- *"I forgot"* - 1 parent
- *No reasons* - 2 parents

4. In total, 12 children from the whole study had received additional treatments following the initial programme. This included the 4 children discussed in the original paper who had all received a further 6 week course of treatment by the first author. The remaining 8 children had received treatment by the following:

- Four (4) by the first author
- One (1) by a physiotherapist local to the child. His mother had reported that the journey to the author's practice had been too far for her to drive.
- One (1) by Occupational Therapists local to the child. In their local Health Authority treatments for Dyspraxia are carried out through the occupational therapy department.
- Two (2) had been referred by their school to the special needs teachers to assist with writing, reading and spelling

Three of the parents reported that the additional treatment had not been helpful as their concerns had been related to school work and their children still continued to have difficulty with spelling, reading and copying from the board.

5. A total of 16 patients from the whole study reported that they did not continue with the monthly checklist. The reasons given for this were:

- “ *We keep forgetting*”
- “*I have lost my copy and have forgotten to ask for a new one*”
- “*Constraints of time*”
- “*My child is physically active and now participates in many sports so there does not seem any point*”
- “*My child is away at boarding school and it is not always possible to complete the checklist apart from when she returns for weekend breaks*”
- “*He does not give us concerns about his co-ordination skills or balance any longer and he is achieving good results at school*”
- “*Difficulty due to family illness*”

6. A total of 51 parents reported that their children now carried out additional sports/activities and hobbies outside school. The variety of these are shown in table 3

Table 3: To show the additional activities/sports carried out by parents

Information from 53 completed questionnaires - some children participated in more than one activity

Sports/activities	No. of children carrying out activity
Swimming	35
Football	12
judo/karate	10
Cycling	6
horse riding	5
Golf	5
Cricket	4
Dance	4
Tennis	4
Netball	4
youth clubs/Beavers/Brownies	4
Gymnastics	3
Chess	2
ten pin bowling	1
Skiing	1
drum playing	1
Rugby	1
Rowing	1
Trampoline	1

Discussion

The authors were very pleased that the 33 children who returned for annual reviews had generally not only maintained their scores with the gross motor skills but in many cases had improved upon them. It appeared that by the third year of reviews none of these children had required further input in any areas. In addition, all of the children, apart from two, had shown improvement in all of their skills. The two children who had not shown further improvement had maintained their scores following the treatment and at the initial review. This review had taken place 3 months following treatment.

In the first year of reviews, 6 of the children had shown an improvement with their proximal stability and ball skills. By the second year a further 11 children had shown an improvement especially with short term memory, proximal stability, ball skills and motor planning and self organisational skills. Similarly, by the third year a further 14 children had shown an improvement in these skills.

Many of the parents who had returned to reviews verbally commented they considered that the improvement and maintenance of their children's scores was due to the fact that their children now carried out more activities both at home and at school. The children had more confidence and were also more willing to attempt new sports.

It was very encouraging that 96% of the returned questionnaires stated that self confidence and self esteem had remained improved. The importance of self confidence and self esteem has been discussed by several authors - Portwood (1999), Lee (1998), Addy (1996), Portwood (1996), Lee & French (1994) and Laszlo & Bairstow (1987). Previous reports have also noted an improvement in self confidence and self esteem following treatment, (Lee & Smith (1998), Addy (1996)). However, there have not been any reported to date, commenting on the improvement in self confidence and self esteem having been maintained over a period of time.

Discussions with those parents whose children returned for annual reviews revealed a willingness by their child to attempt and to participate in new activities. This, in turn, had appeared to improve the child's self confidence and self esteem. Many of the children were also reported to have won a number of awards and certificates, as well as being chosen to play for teams both at school and at sports clubs. This had not only further boosted their self confidence and self esteem, but had also, reportedly, won them respect amongst their peers. The children stated that following the treatment programme they were finding it easier to be accepted by their peers and to make friends.

Parents also reported that they now more readily accepted the fact that their child "would never be a wonderful athlete or fantastic at sports". The parents reported that they felt their children had other qualities which could be built upon, such as a very good imagination or being good at art. Their expectations had altered. Some parents believed that this had decreased the stress placed upon both their child and themselves. There had also been a greater understanding of their child's abilities and inabilities both from themselves and teachers. This, in turn, had made the child feel less threatened by failure and more willing to attempt new tasks. This had further improved the self confidence and self esteem of their child in that they could now attempt activities without feeling threatened by failure.

Interesting results were revealed concerning whether the parents were happy with their child's progress. It had been expected that those who had not returned for review would report that they were happy with their child's progress. However, over half of those who had not returned (13 out of 20) reported that they were not happy. These parents reported that the main reason they had not returned for a review were that they did not relate the current difficulties as being physical in nature. They did not consider that physiotherapy would be beneficial, despite continuing to have concerns.

The remaining parents (7 out of 20) who had not returned for annual review stated that they were happy with their child's physical progress and therefore had not considered it necessary to continue with them. The authors were disappointed that the parents had not been in contact with their physiotherapist to either inform them of the progress, or to obtain an updated checklist in order that they could continue to monitor their child. Only a couple of parents reported that they never appeared to have the time or that they forgot to make appointments for the annual reviews. This would, therefore, indicate that parents do not perceive annual reviews as always necessary. However, a proposal which may allow the physiotherapist to keep in contact with the child would be to have a supplementary questionnaire. This could then be used to gain information on the progress of any child who did not return for reviews.

In the section of the questionnaire relating to the concerns that they had, all parents who completed this section, revealed that their worries were related to school work. The difficulties encountered with school work included:

- poor spelling,
- poor reading,
- poor short term memory
- difficulty with mathematics .

This reinforces the importance of continued assistance in the school classroom. It also suggests that, whilst physical abilities had generally remained improved, difficulties with school work had become more apparent and consequently more important. Many children (33 out of 53) were being seen regularly by a special needs teacher, either at school or privately. This further highlights the importance of continued close liaison between the physiotherapist, class teacher and the special needs tutor to ensure that children with Dyspraxia are supported and monitored throughout their school years.

Three (3) of the non returning parents, had also commented that they additionally had concerns about their child's physical abilities. These three parents indicated that they had not returned for a physiotherapy review because they had either not found the time or had felt that they could carry out at home the activities which had been shown to them during the treatment. Two parents had reported the latter reason and also stated that with the input they had given, their child was making progress with the physical difficulties. These parents also commented that had difficulties continued, they felt confident that they could contact the first author for further assistance. This could, therefore, suggest that one of the vital roles of the physiotherapist is in educating the parent so that they are able to identify difficulties and have some knowledge on how to assist their child with these as they arise.

The 12 children who required further courses of treatment represented 20% of the original study. The parents of 8 of these children, reported that difficulties had become apparent again during a sudden growth spurt between the ages of 7 to 8 years. Significantly, the fact that difficulties can manifest themselves again during growth spurts has been previously reported by Lee & French (1994) and the comments made by the parents would confirm this.

Eight (8) of the children from the whole study had been reviewed by the first author. However, four (4) of the children who had required further courses of treatment had not returned for reviews and had been seen locally as the first author's practice was considered to be too far away.

One of the main areas that the authors wished to ascertain was the usefulness of the long term management programme. The programme consists of the following:

- An annual assessment of the child
- A checklist for parents to complete on a monthly basis. This is to ensure that the newly acquired abilities

remained at an age appropriate level. Parents were asked to complete a list of activities and to ensure that the scores fell between a range previously set by the physiotherapist. The scores used have been documented by Lee (2000) and (1996). An example is given in Appendix B.

- Advice on activities for the child to carry out ranging from additional sports, recreational activities and hobbies. The purpose being to provide an interest, maintain newly acquired skills and muscle strength, promote confidence and encourage social interaction.
- The first author's contact number for the parents, if they became concerned about their child during the year or the scores taken from the checklist fell.

The purpose of the monthly checklist was for parents to monitor their child's progress so that if scores and abilities fell then early intervention could be initiated. It was found that 16 parents of the whole study did not complete the checklist. It had been hoped that the parents would be keen to continue monitoring their children's progress. Ten (10) parents from the whole study reported that the checklist was particularly hard to complete as the additional tasks were not part of a daily or weekly routine. There was also no requirement or arrangements to give regular feedback.

The following questions therefore, still remain as to:

- (i) the necessity of completing the checklist monthly or whether a different form of regular monitoring is required?
- (ii) whether parents should return the completed checklist at predetermined periods of time (e.g. quarterly or half yearly)?

Moreover, with so many parents (52 out of 53), commenting that they were happy with their child's physical development any increased regular monitoring from the physiotherapist would not seem necessary. However, the periodic returning of a completed checklist **would** be useful in order to maintain updated information on each child's general progress.

One positive feedback concerning the checklist was that some parents reported that it had been used when concerns about their child's progress had been raised. It identified whether the scores had fallen and indicated that a physiotherapy assessment was required in order to ascertain if further treatment might be needed. These parents also reported that they had sought help quickly.

The above comments would also suggest that even though the checklist was not completed regularly it had guided parents to act promptly to arrange for additional input if the child began to experience difficulties. As such, one of the main purposes of the checklist would, appear to be as a prompt for further management of the child rather than being used as a means of regular monitoring.

The study also showed that apart from 2 children from whole study, the others were all carrying out additional activities or sports outside school. Most children had reported during their initial assessment that they participated one or two games lessons at school every week but that they did not participate in regular sports clubs or teams. During the physiotherapy programme the children had been encouraged to attempt additional activities but of no more frequency than once or twice a week. In this subsequent study it appeared that the children who carried out additional activities (51) confirmed that they had not carried out more than 2 activities a week. However, the 2 children who did not carry out additional activities reported that they participated in daily sports and activities at school and this was considered to be more than sufficient. The most popular activity reported was swimming followed by football. Parents reported that whilst their children may not have actually been in teams or representing clubs, they felt that the children enjoyed the activities and the social interaction.

The study also identified that the children were participating in other several interesting hobbies such as ten pin bowling, archery, chess, dance and drum playing. Eighteen (18) parents from the study, reported that these additional interests had stopped their children from constantly watching T.V. and that they had encouraged them to pursue them further. Forty three (43) children also commented on badges, certificates and shields being

won following the treatment programme.

Ten of the children had even become “sportsman of the year” at their school. This achievement had improved their self confidence and self esteem tremendously. It also made the children even more willing to attempt new activities and be readily accepted by their peers. These are important factors. One of the dangers of poor self confidence and self esteem is that children will stop trying to achieve. Consequently at school this *could* lead to failure, truancy and in some cases juvenile delinquency (Portwood, 1996 and Laszlo & Bairstow, 1985). Something it is hoped will be avoided in these children because of the positive characteristics reported and described above.

Conclusion

The study revealed a number of encouraging aspects. Firstly, for those reviewed, nearly all the children had continued to improve upon the scores for their gross motor activities, ball skills, short term memory, motor planning and self organisational skills.

The fact that the children’s self confidence and self esteem had improved and even continued to grow was very reassuring, especially for the parents. Furthermore, the children, in general, reported being happy with their own progress and achievements. They reported having become more readily accepted by their peers. Many also reported that they now found it easier to make friends. This showed that the children were not the loners that they had appeared to be at the outset. This alone is an important factor, as recent studies have revealed that adults who did not receive treatment now complain of poor esteem and loneliness (Portwood, 2000 & 1999). It is therefore necessary that these children not only receive the initial treatment programmes they so desperately need but also the post physiotherapy monitoring which ensures that any difficulties manifesting are quickly resolved. This, it is hoped, will then prevent a fall in self esteem and self confidence which could, in turn, prevent the consequences mentioned above from developing.

The study also showed that parents were happy with the physical development of their children. Moreover, that they themselves had gained confidence in knowing how to deal with their child if difficulties did return and what activities were useful to assist them. However, several parents also reported that difficulties and concerns with regards to school work remained. \thus, it is vital that these children have the support of their class teacher and the special needs department, both in the short and long term.

The use of the long term management programme showed encouraging results. The children that had continued to carry out additional activities and hobbies demonstrated a number of positive outcomes. Furthermore, although the monthly checklist had not been completed by every parent it would appear that it does have a role to play. Especially in enabling parents to monitor their child’s scores when concerns are raised.

Thirty three (33) children of the whole study had continued to come for annual reviews but 27 had not. The parents of the latter had, apparently, either been happy with their child’s progress or not considered that physiotherapy could assist with any current difficulties. However, a comment made by some parents was that it was a comfort to know that, if they had concerns, they could contact the physiotherapist. It would therefore, appear from these findings that not all children require constant annual reviews or monthly checks by their parents. Perhaps it is sufficient that, if the parents do become concerned with their child’s physical abilities, they can easily arrange to return to the physiotherapy department.

The subject group in this study will **continue** to be **monitored**. It is further hoped that more long term data will be obtained and published. There is definitely an on going need to confirm that, in the long term, physiotherapy is and remains an extremely effective form of treatment for Dyspraxia.

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Appendix A

Questionnaire completed by all parents

Please complete the questions below. In most cases only a Yes or No answer is required.

1. Are you happy with your child's progress? *Yes no*

2. Do you have any concerns about your child's progress? *Yes no*

If *yes*: Is this related to school work? Please explain:

Is this with physical ability or with sports?

any other concerns?

3. Is your child happy with their own progress? *Yes no*

Please explain and give details on their current self confidence and self esteem:

4. Have you managed to continue to come for physiotherapy annual reviews?

Yes no

if "*no*" is this due to:

(a) You are happy with your child's progress and do not consider it necessary?

(b) it has been recommended that annual reviews are no longer required?

(C) other - please

elaborate

5. Has your child required further courses of treatment from the initial programme?

Yes no

If "yes" was this:

- at the Lee Medical Practice
- by another physiotherapist
- by another professional - please state

6. Do you manage to carry out the monthly physiotherapy checklist given to you at your last review?

If "no" please why this has not been possible:

7. Does your child carry out regular additional sports/activities/hobbies which had been recommended to you at your review?

Yes no

If "yes" please state which ones:

Please move to question 8

If "no" why has this not been possible

Do you alternatively, carry out any exercises or activities from the home programme?

Yes no

If "no" please explain

8. Do you have any further comments concerning the physiotherapy long term management programme, your child's progress or any achievements your child has made since your last review?

APPENDIX B

An example of a checklist given to a 5 year old child

CHECK LIST

Name:

Date of Review:

Instructions:

It is recommended that this checklist is carried out once a month to ensure that your child has maintained the level of progress as from his last review. Your child should be able to carry out the following tasks as are described and achieve the stated number. If your child's scores fall below the recommended scores please call the practice.

Shoulder control:

Wheelbarrows:

Ask your child to place their hands on the floor with the arms straight and lift the legs. You should hold your child at his/her ankles. Their hands should be pointing directly in front of them and the pelvis not sway side to side or with a flexed posture. The hands should also not land heavily on the ground. Your child should be able to achieve between 60 - 80 steps.

Pelvic control:

Standing on one leg:

Ask your child to stand in the middle of a room on one leg. He/she should be able to keep the lifted leg away from the weight bearing one. Your child should be able to hold the position for between 8 - 10 seconds on either leg.

Walking backwards on the knees:

Ensure that your child can walk backwards on his knees with 15 steps without wiggling his/her bottom

Eye hand co-ordination

Ball activities:

Ask your child to throw and catch a football to you 5 times. He/she should be able to throw the ball with good direction and catch the ball away from their body. Also ask your child to throw and catch the ball to themselves with two hands and bounce and catch the ball to themselves 5 times. With all the ball activities your child should be able to achieve the tasks 5 out of 5 times

Eye foot co-ordination

Kicking a ball:

Kick the ball to your child and ask your child to trap the ball and kick it back to you 5 times. Your child should be able to stop the ball 5 out of 5 times and kick a ball with good direction and force.

Active trunk extension

Aeroplane

Ask your child to hold the following position: lying on their stomach with the arms kept beside their body and keeping their legs straight, lift the legs, shoulders and the head. Your child should be able to hold the position between 10 - 15 seconds.

Active trunk flexion:

rolled up ball:

Ask your child to lie on his/her back and lift his/her knees onto their chest. Your child should then hold the knees and lift their head. Time your child. Your child should be able to hold the position for 10 -15 seconds without rolling to either side.

Memory

Ask your child to complete the following (you may change the order, activity and number each

Verbal: 3 claps, 3 hops and 3 jumps

Visual: show your child taking 2 steps forwards, go around in a circle and jump once in the air.

Your child should be able to complete the tasks 3 out of 3

Planning and organisational skills

Ask your child to explain and then demonstrate one of the following. Please ensure that with making a cup of tea or coffee that “play apparatus” is used. Alternatively you may ask your child to make a milk shake or a sandwich.

Your child should be able to complete the task with 6+ correct sequences for making the tea/coffee or 4+ for the squash or milk drink.

For making a cup of tea the sequences should include:

- filling the kettle with water and boiling the water
- getting a cup and placing a tea bag or coffee in the cup
- pouring the water into the cup once the water has boiled
- taking out the tea bag
- adding milk and sugar (if required), stirring
- giving it to the parent or drinking it themselves

For making a milk shake or squash drink your child should include the following sequences:

- getting a glass
- pouring a small amount of squash or milk shake mixture into the glass
- adding the water or milk
- drinking it

For making a sandwich your child should demonstrate the following sequences:

- getting out a plate and knife
- getting the spread/butter, slices of bread and filling
- spreading the butter onto the bread
- placing the filling on top of one of the slices of bread
- Are there any problems placing the other slice of bread on top
- eating it

Spatial awareness

does your child knock into objects or furniture or other people?

Barriers to research in D.V.D.

by

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Abstract

Developmental verbal dyspraxia continues to be one of the most controversial conditions in Speech and Language Pathology. In the published literature, there remains little agreement on terminology, symptomatology, diagnostic features and indeed its very existence. There is still no empirically identified group with developmental verbal dyspraxia, and yet clinicians continue to believe that there is a subgroup of children with speech disorders for whom this label is appropriate. This paper aims to update previous literature reviews on the subject (Guyette and Diedrich 1981; Stackhouse 1992) by reviewing current knowledge from three perspectives: theoretical issues, assessment and treatment. It is concluded little progress appears to have been made as far as developmental verbal dyspraxia is concerned, but advances within the wider domain of speech disorders eg. Psycholinguistic approaches to assessment and treatment (Stackhouse and Wells 1997) and subgrouping of speech disorders of unknown aetiology (Dodd 1995; Bradford and Dodd 1996) may well hold the key to future progress in the specific area of developmental verbal dyspraxia.

Introduction

Dyspraxia was first applied to children's speech difficulties by Morley, Court and Miller (1954): "a defect of articulation which occurs when movements of the muscles used for speech.....appear normal for involuntary and spontaneous movements...but are inadequate for the complex and rapid movements used for articulation and reproduction of sequences of sounds used in speech."

Despite almost 50 years of research, the condition remains poorly understood and the subject of controversy (Stackhouse 1992, Ozanne 1995, Bradford and Dodd, 1996 McCabe et al. 1998.) There is debate in the literature regarding terminology, definition, symptomatology, diagnostic features, therapy techniques and the very existence of developmental verbal dyspraxia (McCabe et al 1998).

Ten years ago, Stackhouse (1992), in a comprehensive paper on developmental verbal dyspraxia, reported that to date, no subgroup of children with dyspraxia had been empirically identified within the speech-disordered population. She advised that the validity of research published to date was questionable due to:

1. methodological difficulties, particularly concerning subject selection and study design,
2. the lack of a thorough description of the children's presenting difficulties
3. the lack of a developmental perspective. Stackhouse proposed that future research studies needed to include both normal controls and longitudinal individual case studies, in order to advance current knowledge of this complex condition.

In spite of the controversy and a lack of tight empirical evidence, clinicians continue to believe that developmental verbal dyspraxia is an identifiable clinical entity (Stackhouse 1992; McCabe et al 1998). However, clinician surveys indicate differences of opinion between clinicians and researchers on the precise identifying features of developmental verbal dyspraxia (McCabe et al 1998).

This paper reviews current knowledge of developmental verbal dyspraxia from the perspectives of theoretical issues, assessment and treatment, with a particular focus on advances in the past 10 years.

Theoretical issues

One of the controversial issues with developmental verbal dyspraxia involves terminology and definitions. Muriel Morley first adopted the term ‘developmental articulatory dyspraxia’ and this remained in clinical use until the mid 1980s in the UK. Since that time, the preferred term has been developmental verbal dyspraxia, which acknowledges that most children present with both speech and language difficulties. The preferred term in USA is developmental apraxia of speech. It has been suggested by some authors that the choice of terminology used may indicate theoretical understanding i.e. that developmental apraxia of speech indicates a motor based deficit, whereas developmental verbal dyspraxia indicates a linguistic based deficit. To avoid confusion, some authors have advised the term developmental dyspraxia, although this is also not simple as it can be confused with children who present with primary motor co-ordination difficulties rather than speech difficulties.

Historically, definitions of developmental verbal dyspraxia took either a motoric or linguistic bias according to the individual viewpoint of the author. More recently, definitions incorporating motoric and linguistic deficits have been proposed:

Byers-Brown and Edwards (1989) “We consider developmental dyspraxia to be an impairment in the selection, planning and programming of linguistic and of motor schemata for the production of language” and:

Crary (1993) “Developmental apraxias of speech are a group of phonological disorders resulting from disruption of central sensorimotor processes that interfere with motor learning for speech”

Probably the most controversial aspect with developmental verbal dyspraxia has been its identification, within the wider group of children with developmental speech disorders. This wider group constitutes approximately 5% of the normal primary school population and they represent about 70% of children who attend speech and language therapy clinics (Fox, Dodd and Howard 2002). These children do not form a homogenous group- they are known to differ in terms of severity, aetiology, presenting speech difficulties and in their responses to different treatment approaches (Dodd 1995). Only a small proportion of children with speech disorders have identifiable aetiological or organic deficits eg cleft palate, cerebral palsy and hearing loss, for the majority there is no obvious organic aetiology.

Attempts to identify a subgroup of children with developmental verbal dyspraxia have not been successful to date. As long ago as 1974, Yoss and Darley reported a study that differentiated between a group of children with dyspraxia and a group with functional speech disorder, on the basis of neurological ratings (difficulties with fine motor co-ordination, gait and diadochokinetic control), volitional control of isolated oral movements and speech errors. However, an attempt to replicate this study by Williams, Ingham and Rosenthal (1981) was unsuccessful. Although the authors proposed possible explanations for the differing findings, it gave support to Guyette and Diedrich’s (1981) conclusion from their detailed literature review that “developmental apraxia of speech is a label in search of a population”.

The theme of sub-grouping of speech disorders has become a popular research strand in recent years. Dodd (1993; 1995; 1996; 2002) is particularly known for her work in this field. On the basis of surface speech errors produced on speech tests, Dodd proposed four subgroups of children who have speech disorders of unknown origin:

- articulation disorder
- phonological delay
- deviant consistent phonological disorder
- deviant inconsistent phonological disorder

Each is associated with a particular pattern of performance on speech tests and is presumed to arise from a different underlying deficit. In a recent paper, Fox, Dodd and Howard (2002) demonstrated that risk factors, including pre-and perinatal problems, E.N.T. problems, sucking habits and positive family history

differentiated between speech-disordered and normally-speaking children. However, attempts to identify specific risk factors with each proposed subgroup were unsuccessful. In an earlier paper, Bradford and Dodd (1996) had included a subgroup of children with developmental verbal dyspraxia, along with groups with phonological delay and disorder and normal controls in a study investigating motor deficits. Group assignment was carried out by two experienced speech and language therapists on the basis of speech profile on single word and connected speech tests and performance on oral and speech motor control tasks. The findings showed different patterns of performance for each group, suggesting that the subgroups are distinct and distinguishable from one another. The results supported the notion of developmental verbal dyspraxia as a multi-deficit disorder (Ozanne 1995) which included difficulties with oro-motor planning and in implementing fine motor actions, in addition to a distinctive pattern of speech errors.

Despite these findings, evidence from clinical practice suggests that clinicians remain uncertain of subgrouping children's speech difficulties. Whereas there is widespread agreement on what constitutes speech impairment in comparison to normal development and recognition of what constitutes delay in comparison to disorder, there is less certainty on further subgrouping. For clinicians to become convinced, further work is required to demonstrate that there are clearly defined subgroups, which can be readily identified by clinicians on standardised assessment measures.

Identification of developmental verbal dyspraxia as a distinct clinical entity, has proved a major challenge for researchers. It is generally acknowledged that a distinct clinical entity has at least one or more identifying pathognomonic features or clinical markers. In the case of developmental verbal dyspraxia, a number of features have been proposed. These include: oromotor difficulties, difficulties with diadochokinetic tasks, vowel misarticulations, inconsistent productions, unusual stress patterns and generalised motor impairment. To date, none of these has been identified as only occurring in children with developmental verbal dyspraxia as distinct from other speech disorders and none is universally accepted.

Given the lack of identified pathognomonic features for developmental verbal dyspraxia, the current popular view is to think of it as a symptom complex consisting of a range of features and characteristics. Indeed, Hall (1995) advises that such an approach eliminates the debate over its existence as a distinct disorder.

However the symptom complex approach is also fraught with difficulty as highlighted by Jaffe (1986):-

“ Developmental Apraxia of speech is defined by a symptom cluster...not all symptoms must be present; no one characteristic or symptom are present and the typically reported symptoms are not exclusive to developmental apraxia of speech. Compounding the problem is the observation that children change over time.”

A number of symptomatology lists, based on features reported in the literature, have been published eg Jaffe (1984), Pollock and Hall (1991), Stackhouse (1992), McCabe et al (1998), Davis et al (1998). There is common overlap of features on these “checklists” which usually include clinical, linguistic and cognitive factors in addition to the core speech features but there is rarely advice on how many of the features need to be present for a diagnosis to be made or indeed whether one or more features must be present for the diagnosis to be made. However, Stackhouse (1992) warned that speech features alone should not be used as a basis for diagnosis and that ideally there should be evidence from each of the 4 perspectives (clinical, cognitive, linguistic and phonetic) over time in order to apply a label of developmental verbal dyspraxia with any confidence. Developmental verbal dyspraxia is an unfolding and changing condition, which presents differently at different ages and stages and this further complicates diagnosis (Stackhouse 1992).

Therefore, the situation described by Shriberg et al (1997) remains unchanged: “Currently there is no descriptive, diagnostic or theoretical consensus on the nature and origin of developmental apraxia of speech”. Given this position, published group studies of children with developmental verbal dyspraxia are now rare.

Clinicians views

Stackhouse (1992) observed that despite the lack of tight empirical evidence, clinicians appear to believe that developmental verbal dyspraxia is an identifiable clinical entity. In a questionnaire study involving 31 clinicians, Williams, Packman, Ingham and Rosenthal (1980) reported 4 behaviours that they always associated with developmental verbal dyspraxia:

1. deviant rather than immature articulatory behaviour
2. searching behaviour when trying to produce phonemes
3. inability to produce individual or sequences of phonemes volitionally
4. inconsistent pattern of errors.

A subsequent study by Murdoch et al (1984) found similar results. In reviewing the results, McCabe et al (1998) observed that clinicians views concerning features of developmental verbal dyspraxia do not always mirror those reported in the research literature, suggesting that research and clinical practice do not sit well together. Unfortunately, the validity of the questionnaire findings has since been shown to be questionable on account of the methodological design (Stackhouse 1992).

Observation of current clinical practice led Shriberg et al (1997) to comment that the label of “suspected DAS” may provide clinicians with a functional solution to children whose profile differs from those with straightforward speech delay, who fail to progress in an expected manner and who are in some way a “puzzle”. Davis et al (1998) developed this theme and suggested that clinicians may apply the term rather too freely to any child who presents with multiple articulation errors and a very slow rate of progress. In their study of 22 children thought to be dyspraxic by their clinicians, the diagnosis was only confirmed in 4/22 once more stringent testing involving measures of oromotor, speech and language skills was made in a university research clinic.

Therefore, clinicians appear to believe that there is a subgroup of children with developmental verbal dyspraxia as distinct from other speech disorders. However, their views on defining characteristics do not necessarily accord well with published research findings and there is some indication that they might apply the term too widely.

Assessment

Another problem facing clinicians is the lack of a published and standardised measure which can be used to identify developmental verbal dyspraxia. The Nuffield Dyspraxia Programme Assessment (Connery 1992) provides a norm referenced measure which includes an oromotor and prosody assessment, and speech assessment subtests for: single sounds, sound and syllable sequences, single word naming of words of increasing phonotactic complexity and sentence repetition. However, the assessment is not a differential diagnostic measure and in any case, anecdotal evidence suggests that clinicians use it far less than they use the Nuffield Dyspraxia Programme therapy resource.

Assessment of speech disorders in general is problematic for clinicians. In the UK, there has only been one standardised single word naming test published to date, which enables clinicians to differentiate between normal and atypical speech development. The Edinburgh Articulation Test (Anthony et al 1971) is now out of print but remains in use by researchers who use it to establish that a child has a speech impairment. In comparison, clinicians now favour non-standardised, qualitative measures eg South Tyneside Assessment of Phonology (STAP) to assess children’ speech difficulties, demonstrating again that research and clinical practice do not necessarily agree.

In recent years, the notion that children’s speech difficulties can be accurately assessed and interpreted on

single measures of speech output has been challenged by proposed psycholinguistic approaches (Stackhouse and Wells 1997; Hewlett et al 1998). In such approaches, children's speech difficulties are seen as being derived from a breakdown in the speech processing chain at one or more levels of input, stored linguistic knowledge and output. These approaches rely on the use of speech processing models and hypothesis testing with the aim of allowing clinicians to go beyond description to explanation. In the UK, the Stackhouse and Wells approach has become popular with clinicians, who recognise the good practice in such an approach to assessment and treatment. However, over-stretched clinicians remain challenged by the need to carry out a wide range of detailed assessments.

Psycholinguistic approaches also offer clinicians an alternative to the subgrouping approach, which has proved so problematic. Clinicians are "given permission" to transcend labels and to use the umbrella term of speech disorder to describe children's speech problems, providing that a detailed profile of the child's individual strengths and weaknesses is provided. However, many clinicians continue to believe that they should be able to differentially diagnose speech disorders, and certainly, this is usually expected by other professionals and parents.

Treatment

Just as there have been numerous papers written on the theoretical aspects of developmental verbal dyspraxia, there have also been many attempts to propose therapy approaches and strategies for managing the condition. Confusions over the existence of the disorder and its exact presentation have limited agreement on the therapy approach that should be adopted. What distinguishes one therapy approach from another is the author's theoretical understanding of the condition either as a motor programming /planning disorder, as a linguistic, phonological disorder or as a combined motor /linguistic disorder. The most popular approach to developmental verbal dyspraxia has involved a focus on speech production, but other approaches have included a focus on manual communication and a focus on linguistic aspects including phonology and syntax.

Unfortunately, efficacy studies of treatments remain rare, although some single case studies have been published (Harlan 1984; Marquardt and Sussman 1991; Connery 1994; Watson and Leahy 1995).

In the UK, the Nuffield Dyspraxia Programme (Connery 1992) remains the most popular published clinical resource for working on motor programming aspects of speech. This pictorial resource draws on principles of motor learning theory to provide clinicians with a systematic approach to speech work. However, many clinicians do not use this approach alone, rather they combine this motor approach with other auditory-perceptual and cognitive-linguistic approaches. Such an eclectic approach has also been supported in the literature (Marquardt and Sussman 1991).

At the current time, there is no agreed therapy approach for developmental verbal dyspraxia and evidence from the wider literature on developmental speech disorders is that the same is true for other speech disorders. Roulstone and Wren (2001) reported a small scale study of therapeutic practice and found that clinicians were eclectic in their approach, drawing on different approaches with different underlying theoretical perspectives to provide individual therapy programmes for their clients with speech disorders.

There is therefore no agreed treatment for developmental verbal dyspraxia and little published evidence of efficacy in either the narrow field of developmental verbal dyspraxia or in the wider speech disorders domain (Law et al 1998).

In conclusion

This paper has reviewed current knowledge of developmental verbal dyspraxia with regard to three different perspectives: theoretical issues, assessment and treatment, with a particular focus on advances in the past 10 years. It is concluded that within the narrow field of developmental verbal dyspraxia, little appears to have

changed- there remains no descriptive, diagnostic or theoretical consensus on its nature and origin nor is there agreement on assessment and treatment approaches. The search for developmental verbal dyspraxia (Ozanne 1995) has therefore not been solved. However, within the wider domain of speech disorders, there have been some encouraging advances eg. Psycholinguistic approaches to assessment and treatment (Stackhouse and Wells 1997) and subgrouping of speech disorders of unknown aetiology (Dodd 1995; Bradford and Dodd 1996) and these may well hold the key in the future to progress in the specific area of developmental verbal dyspraxia. Given that it is clinicians who continue to believe that there is a subgroup of children who have developmental verbal dyspraxia, clinically-led research based on detailed, longitudinal single case studies may provide the best way forward in the short term.

The potential role of fatty acids in developmental dyspraxia – can dietary supplementation help?

by

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Summary

1. Developmental dyspraxia shows substantial overlap with other developmental conditions including dyslexia, ADHD and the autistic spectrum, both within individuals and within families. This indicates some common predisposing factors at the biological level, and the proposal considered here is that these could involve aspects of fatty acid metabolism.
2. Certain HUFA of the omega-3 and omega-6 series are essential for normal brain development and function. Together they should make up around 20% of the dry mass of the brain, and adequate supplies are also crucial for efficient information processing within the brain and nervous system, as well as for many aspects of general health.
3. These key HUFA are often lacking from modern diets and must therefore be manufactured within the body from simpler essential fatty acids (EFA). However, this process is inefficient in humans, and can also be blocked by dietary and lifestyle factors. Furthermore, dietary intake of the necessary omega-3 EFA in particular is often low.
4. The predisposition to dyspraxia and related conditions may involve mild constitutional inefficiencies of fatty acid metabolism that increase the usual dietary requirements for HUFA. These could include (a) poor EFA-HUFA conversion, (b) difficulties in incorporating HUFA into brain cell membranes and/or (c) unusually high rates of HUFA breakdown and loss, although there are other possible mechanisms.
5. Many features associated with dyspraxia are consistent with HUFA deficiencies or imbalances. These include the core difficulties with motor coordination, attention and sensory processing, as well as the excess of males affected, proneness to allergic or autoimmune conditions, disturbances in temperature regulation and sleep, and irregularities of mood.
6. There is already some experimental evidence for fatty acid abnormalities in ADHD, dyslexia and the autistic spectrum. Although dyspraxia has never been ‘factored out’ in studies of these related conditions, no studies of dyspraxia per se have yet been reported although these are now underway.
7. If fatty acid deficiencies were a contributory factor in these developmental conditions then dietary supplementation with HUFA might be of benefit. In ADHD, a few controlled treatment studies have been reported, with mixed results; and in dyslexia, the first controlled trial has shown that treatment with omega-3 and omega-6 HUFA can reduce attentional problems, anxiety, and disruptive behaviour.
8. In dyspraxia, no properly controlled trials of HUFA supplementation have yet been reported. One small open study indicated possible benefits, but without a placebo control group these cannot be attributed to the

treatment itself. A large-scale randomised controlled trial of HUFA treatment in dyspraxic children is now underway.

9. As yet there is therefore no firm evidence of benefits from HUFA supplementation in dyspraxia, although many people are already trying this approach. HUFA are generally safe and have many general health benefits, but medical advice is recommended before taking any food supplement. Furthermore, fatty acid supplements vary widely in their composition and quality. Available evidence indicates that omega-3 fatty acids – and particularly EPA – may be most effective, but this still requires confirmation.
10. Other aspects of diet may also merit attention, but nutritional intervention is obviously only one aspect to consider in the management of dyspraxia, and cannot be expected to benefit more a subset of affected individuals. Some features that may indicate a good response to HUFA supplementation have already been identified, but further research is needed to verify their predictive power.

Introduction

Dyspraxia or developmental co-ordination disorder (DCD)¹ remains one of the least studied of a range of common and interrelated developmental disorders of childhood. Conditions showing substantial overlap include dyslexia, attention-deficit / hyperactivity disorder (ADHD) and autistic spectrum disorders (ASD). Dyslexia refers to specific difficulties in the acquisition of written language skills, but these are part of a developmental syndrome involving a much broader range of features (Miles, 1994). The ADHD diagnosis involves hyperactive and impulsive behaviours, attentional difficulties, or both; but controversy still surrounds this diagnosis and its treatment (NIH Consensus Statement 1998). In autistic spectrum disorders, the central features are specific difficulties in social interaction and communication and a restricted range of behaviours, but again, diagnosis is fraught with difficulties and the clinical picture includes many other features (Jones, 2000). In practice, therefore, there is substantial variability within each of these diagnostic categories, and most affected individuals show features of more than one of these conditions, i.e. ‘pure’ cases are the exception, not the rule.

Between them these developmental conditions affect more than 10% of the school-age population; and as they all have a dimensional aspect, milder difficulties are even more common. Although they often go unrecognised, the earlier these kinds of behavioural and learning difficulties can be identified, the better are the chances of successful management and remediation. However, because the formal diagnoses of dyspraxia, dyslexia, ADHD, and ASD all involve different sets of operational criteria, each tends to involve specialists from different professional disciplines and therefore different management approaches. Unfortunately, practitioners dealing with any one of these conditions may be unfamiliar with at least some of the others, and thus unaware of co-morbidity issues and their implications.

In none of these conditions is the possible role of nutrition considered as part of standard evaluation and management, despite its obvious and fundamental importance for optimal functioning of the brain. A whole range of micronutrients is essential in this respect, but in particular, there is mounting evidence – summarised here - that deficiencies or imbalances in certain highly unsaturated fatty acids (HUFA) of the omega-3 and omega-6 series may contribute to both the predisposition and the developmental expression of dyspraxia and related conditions (Richardson and Ross, 2000). This raises the possibility that dietary supplementation with the relevant HUFA might help in their management, but further research is needed to investigate this. Very few properly controlled treatment trials have yet been carried out, and these have involved children with a primary diagnosis of either ADHD or dyslexia, although a trial involving dyspraxic children is now in progress

¹ In neuropsychology, dyspraxia refers to specific problems in the planning and execution of complex, sequenced actions - the most obvious of which involve motor co-ordination difficulties. The DCD diagnosis adopted by the DSM-IV (American Psychiatric Association, 1994) is much broader, but developmental dyspraxia has come to be used by many in a similarly general way, as it will be here for convenience.

(Richardson and Portwood, in preparation). What evidence there is from trials of fatty acid treatment in related conditions is therefore considered here, followed by a discussion of the potential practical implications.

Associations between dyspraxia and other behavioural and learning difficulties

The overlap between dyspraxia and dyslexia is between 30-50% in both directions, depending on the exact criteria and ‘cut-off’ points used in each diagnosis. Individuals with both conditions often show more difficulties with spelling, handwriting and written expression than they do with reading per se, and other common features include directional confusions, weaknesses in working memory and the sequential organisation of ideas, and inefficient automatisisation of skills. It seems likely that dyspraxia may involve the same kinds of difficulties in rapid visual processing that have already been well-documented in dyslexia (Stein and Walsh, 1997), although this has not yet been formally investigated. Within dyslexia, poor motor coordination has also been particularly associated with attentional difficulties (Denckla et al, 1985), suggesting that the interface between dyslexia and dyspraxia also overlaps into the broad territory of ADHD. However, motor abnormalities in early development appear to be fundamental to dyslexia (Haslum, 1989), as are general difficulties in the automatisisation of skills; hence the cerebellum has become a focus of recent study. This brain region is crucially involved in motor control, but also plays a key role in cognition; it is especially important for the acquisition of any new skills (including language) as well as the smooth performance of previously mastered skills. Cerebellar activation in dyslexic adults was found to be dramatically lower than that of non-dyslexic adults during both acquisition of new skills and the performance of previously learned skills (Nicolson et al, 1999), and metabolic differences in cerebellar activity in dyslexia have also been reported (Rae et al, 1998). Dyspraxia has not usually been considered in studies of dyslexia, but this – as well as separate studies of dyspraxia - is clearly long overdue; and anomalies of cerebellar function seem more than likely in this condition (Nicolson, 2000).

The mutual overlap between dyspraxia and ADHD can also be as high as 50%. Population studies indicate that this combination syndrome, involving deficits in attention, motor control and perception (DAMP), may actually identify a much more homogeneous group than does the ADHD diagnosis. Furthermore, long-term follow-up studies indicate that these children – who meet criteria for both DCD and ADHD at primary school entry - have a particularly poor prognosis in terms of later achievement and social adjustment (Hellgren et al, 1994; Rasmussen and Gillberg, 2000). Within ADHD, different underlying factors probably contribute to the two dimensions of attentional difficulties and hyperactivity-impulsivity, and the former seem more fundamentally associated with dyspraxia. Such attentional problems are often associated with emotional sensitivity, mood swings and anxiety, which may be ‘internalised’ and thus not always obvious to others. By contrast, hyperactive and impulsive behaviour is more ‘externalised’ and overtly disruptive, but this can be associated either with apparent ‘carelessness’ and a remarkable *lack* of anxiety, or with powerful emotional frustration and a tendency to cycle between a tense, overaroused state and periods of apparent apathy and fatigue. There is mounting evidence that in many cases, apparent ‘ADHD’ symptoms of either variety may actually reflect an underlying mood disorder – either depression, or even bipolar (manic-depressive) traits. This issue is emphasised by Papolos and Papolos (1999) in their excellent book on bipolar disorders in children; and it has very important implications for management, because the stimulant medications typically used to control ADHD symptoms can have disastrous consequences for children with a bipolar temperament. The fact that omega-3 fatty acids have been found to stabilise mood swings in adult bipolar disorder (Stoll et al, 1999) make this an approach well worth exploring in either children or adults with an ‘ADHD’/bipolar profile.

The overlap between dyspraxia and autistic spectrum disorders is also substantial, particularly for milder forms of the latter such as Asperger’s syndrome. Early difficulties with feeding are common in both cases, often associated with digestive problems that may reflect food allergies or intolerances. These - together with the so-called ‘leaky gut’ syndrome - still remain a source of controversy that will only be resolved by further investigation, but sensitivity to cow’s milk appears to be a real issue for some individuals, and the predisposition to dyspraxia and related conditions may well involve overactive immune responses, as discussed later. Other features common to dyspraxia and the autistic spectrum include sleep problems, poor temperature

regulation, physical anhedonia and/or hypersensitivity to touch, and excitability or instability of mood. These physical features are well known to both clinicians and those directly affected by these conditions, but unfortunately most research to date has largely neglected these kinds of physiological aspects, focusing rather on the behavioural or cognitive features of each condition.

In summary, diagnostic criteria for the four conditions considered here are completely different, and yet the evidence shows that boundaries between them are far from clear-cut. This is not surprising when we remember that the diagnostic labels used to classify developmental disorders simply describe patterns of behaviour. They do not provide any explanation of the *causes* of that behaviour – which are almost always multifactorial, and may differ substantially between individuals with exactly the same clinical diagnosis. When it comes to management, it therefore makes sense for practitioners to focus on treating the individual concerned, and to attempt to identify any factors that may be relevant to their particular difficulties. An excellent case study of a boy with ‘dyslexia’ exemplifies this approach (Baker, 1985). Biochemical investigations of this child revealed fatty acid deficiencies as well as other imbalances that were easily corrected via nutritional management, and improvements in schoolwork followed. As the author acknowledges, single case studies of this kind cannot provide definitive evidence, and this approach is likely to help only a subset of children with the ‘dyslexia’ label. However, it is hard to disagree with his statement that *‘when the stakes are high, and the risk or cost is low, it makes sense to consider any factor that has reasonable odds of playing a role’*.

The perspective taken here is that dyspraxia, dyslexia, ADHD and autistic spectrum disorders are all highly complex developmental syndromes with a constitutional basis. As readers of this journal will already be aware, the developmental dyspraxia label itself can encompass a very broad and varied range of features. However, some of this variation undoubtedly reflects the high clinical overlap with these other developmental conditions, and the many associated features they share point to some common underlying factors at the level of biological predisposition. These could plausibly include anomalies of fatty acid metabolism, acting to increase the usual dietary requirement for certain highly unsaturated fatty acids that are essential for optimal brain development and function, but are unfortunately lacking from many modern diets.

Familial associations and genetic factors

Dyspraxia, dyslexia, ADHD and autistic spectrum disorders not only overlap within the same individuals, but also cluster within the same families, as do many of the associated physical features (such as elevated rates of non-right-handedness, and an apparent increased susceptibility to allergic or autoimmune disorders). Some psychiatric conditions also appear to be associated with these developmental ones, including depression, bipolar (manic-depressive) disorder, substance abuse, antisocial or other personality disorders and schizophrenia. It has been proposed that ‘phospholipid spectrum disorders’ might better describe this diverse range of interrelated conditions than do the current diagnostic labels (Peet, Glen and Horrobin, 1999), because there is now mounting evidence that abnormalities of fatty acid and phospholipid metabolism play at least some part in each case, and could perhaps help to explain some of their overlap.

In all these conditions there is a clear genetic component, but the evidence indicates several if not many different genes acting together to increase or reduce risk; and the very high prevalence of dyspraxia and related developmental conditions indicates that the predisposing genes for these are widely distributed in the general population. No specific genes have yet been identified, but it seems likely that some will be found to play a part in more than one of these conditions.² A review of proposed sites of genetic linkage to this range of developmental and psychiatric conditions shows many commonalities, and many of these sites also contain genes known to be important in phospholipid and fatty acid metabolism (Bennett and Horrobin, 2000).

² It is important to make clear that there are not - and never will be - any genes *‘for’* behaviourally-defined conditions such as dyspraxia, dyslexia, ADHD, or autism – because genes simply do not operate at that level. Genes provide coded information for making different kinds of proteins - the basic building blocks for bodies and brains, and for the enzymes that constantly regulate the innumerable complex biological processes involved in living. Therefore genes cannot possibly account directly for any complex, socially-learned behaviours, although they can certainly help to shape the *predisposition* to such behaviours.

In discussing genetic factors it is crucial to emphasise that ‘genetic’ does not mean ‘fixed’ or ‘pre-determined’. Environmental factors (both physical and social) are constantly acting to regulate gene expression, such that genes are actually being switched on and off every millisecond in response to a whole array of ‘environmental’ stimuli. These include what we experience through our senses as well as what we take in through our skin, via the air that we breathe, and also – most relevant to the topic under discussion here – from the food that we eat. Thus genetic and environmental influences are inextricably linked, and the tedious ‘nature *versus* nurture’ issue so beloved of journalists is largely meaningless. Environmental factors (including other genes) influence gene expression; and conversely, genetic factors can lead individuals to select certain aspects of their environments. It is also worth emphasising that most environmental factors can usually be modified rather more easily than can genes.

Fatty acid metabolism actually lies at the interface of gene-environment interactions, because individual differences exist for many genes that influence the absorption, transport and utilisation of fatty acids; and the expression of individual genetic differences of all kinds depends heavily on dietary intake of fatty acids, both during development and throughout life. These points are discussed further in a recent book containing a wealth of accessible information on the importance of lipids in the evolution of the modern human brain, and the relevance of this for developmental and psychiatric conditions, particularly schizophrenia (Horrobin, 2001). The central proposal is that the individual differences underlying these conditions are actually as old as humanity, but that their developmental expression will depend crucially on dietary fatty acid intake.

The role of fatty acids in adult psychiatric conditions has now started to receive considerable attention, not least because omega-3 fatty acids (found naturally in fish oil, but often seriously lacking from modern diets) appear to be a very promising new line of treatment. Benefits from omega-3 supplementation – and particularly the fatty acid EPA - have now been demonstrated in controlled trials of schizophrenia (Peet et al 2001; Peet and Horrobin, 2002a) bipolar (manic-depressive) disorder (Stoll et al, 1999), and most recently, treatment-resistant depression (Nemets et al, 2002; Peet and Horrobin, 2002b). Similar research concerning the developmental conditions is still in its early stages, but the evidence from these studies will be discussed later. Meanwhile, an overview of the nature and importance of highly unsaturated fatty acids is first provided, followed by the background evidence for fatty acid deficiencies or imbalances in dyspraxia and related conditions.

Fats and the brain – essential fatty acids (EFA) and highly unsaturated fatty acids (HUFA)

It is not widely appreciated (particularly by those who choose to adopt ‘low-fat’ or even ‘no-fat’ diets) that 60% of the non-water content of the human brain is actually fat. Moreover, just four highly unsaturated fatty acids should make up around 20% of the brain’s dry mass: EPA and DHA from the omega-3 series, and DGLA and AA from the omega-6 series. What makes these fats so special is the number of ‘double-bonds’ in their long carbon chains, which give them unique biological properties. By contrast, saturated fats have no such double bonds (the carbon atoms are literally ‘saturated’ with hydrogen atoms) while ‘monounsaturated’ fats such as oleic acid, found in olive oil, have just one double-bond.

Table 1: Omega-6 and omega-3 fatty acids

The truly essential fatty acids (EFA) that cannot be synthesised within the body are linoleic acid (LA) of the omega-6 series and alpha-linolenic acid (ALA) of the omega-3 series. The longer-chain, highly unsaturated fatty acids (HUFA) that the brain needs can 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). However: **the conversion of EFA to HUFA is relatively slow and inefficient in humans, so pre-formed HUFA from dietary sources may be needed to ensure an adequate supply of these vital nutrients.**

OMEGA-6 series		Enzymes involved in HUFA synthesis	OMEGA-3 series	
Linoleic (LA)	18:2	<i>Delta 6- desaturase</i>	Alpha-linolenic (ALA)	18:3
9			9	
Gamma-linolenic (GLA)	18:3	<i>Elongase</i>	Octadecatetraenoic	18:4
9			9	
Dihomogamma-linolenic (DGLA)	20:3	<i>Delta 5-desaturase</i>	Eicosatetraenoic	20:4
9			9	
Arachidonic (AA)	20:4	<i>Elongase</i>	Eicosapentaenoic (EPA)	20:5
9			9	
Adrenic	22:4	<i>Elongase, Delta 6- desaturase, Beta-oxidation</i>	Docosapentaenoic (DPA)	22:5
9			9	
Docosapentaenoic (DPA)	22:5		Docosaheptaenoic (DHA)	22:6

Four HUFA are particularly important for brain development and function: DGLA and AA from the omega-6 series, and EPA and DHA from the omega-3 series.

- AA and DHA are major structural components of neuronal membranes (making up 20% of the dry mass of the brain and more than 30% of the retina).
- EPA and DGLA are also crucial, but they play functional rather than structural roles.
- EPA, DGLA and AA (but not DHA) are needed to manufacture *eicosanoids* - hormone-like substances including prostaglandins, leukotrienes, and thromboxanes - that play a critical role in the moment-by-moment regulation of a very wide range of brain and body functions.

Fatty acids from one series cannot be converted into the other within the body. However, both are essential, and the balance of omega-3 and omega-6 fatty acids is very important, as they play complementary roles in many biological functions.

For example, derivatives of AA include the ‘pro-inflammatory’ series 2 prostaglandins, while DGLA and EPA give rise to ‘anti-inflammatory’ prostaglandins (series 1 and series 3 respectively). Similarly, thromboxanes derived from AA act to constrict blood vessels while those derived from EPA act to relax blood vessels and improve blood flow.

If these four key HUFA are not directly available in the diet, they can in theory be manufactured within the body from simpler ‘essential’ fatty acids (EFA), as shown in Figure 1. However, it has only recently become clear that this EFA-HUFA conversion process is actually very slow and inefficient in humans (Salem et al, 1999; Pawloski et al, 2001; Brenna, 2002), probably reflecting the fact that we evolved on a ‘hunter-gatherer’ diet that was very rich in pre-formed HUFA. To make matters worse, this pathway for HUFA synthesis is further impeded by a wide range of dietary, lifestyle or chance factors that can act to block the enzymes required (Brenner, 1981). These inhibiting factors include:

- a high dietary intake of saturated fats, hydrogenated or ‘trans’ fatty acids (the artificial fats found in most margarines and processed foods),
- lack of the necessary vitamin and mineral co-factors (particularly zinc, magnesium and vitamins B3, B6 and C)
- heavy use of caffeine (found not only in coffee and tea, but in a wide range of soft drinks including coca-cola)
- viral infections
- high levels of the hormones released in response to stress.

Other relevant lifestyle factors include heavy consumption of alcohol, and smoking, although these primarily appear to act by destroying HUFA rather than preventing their synthesis. Their effects in depleting HUFA levels are so reliable and pronounced that these factors need to be carefully controlled whenever HUFA status is under experimental investigation.

Why HUFA are essential for normal brain development and function

Structurally, AA and DHA are key components of brain cell membranes, making up 15-20% of the brain's dry mass and more than 30% of the retina. Adequate supplies of these HUFA are therefore essential during prenatal development, and the placenta has been shown to double the levels circulating in maternal plasma in order to meet the needs of the growing baby's brain (Crawford et al, 2000). Severe HUFA deficiencies can have permanent effects if they occur during critical periods of neural development, but milder deficiencies are likely to give rise to more subtle developmental difficulties (Crawford, 1992). The omega-6 fatty acid AA is crucial to brain growth, and mild deficiencies are associated with low birth weight and reduced head circumference, while the structural omega-3 fatty acid DHA is particularly concentrated in highly active sites such as synapses and photoreceptors, and is essential for normal visual and cognitive development (Neuringer et al, 1994).

In early life, HUFA are essential in supporting further brain growth and maturation and are therefore found in breast milk, although they are still not present in many formula feeds. Carefully controlled studies comparing the effects of infant formula with and without pre-formed HUFA have shown clear advantages for both visual and cognitive development from their addition (Makrides et al, 1995; Willatts and Forsyth, 2000)

Throughout life, adequate supplies of HUFA remain crucial for optimal brain function. They are essential for maintaining the fluidity or elasticity of neuronal membranes (while saturated, hydrogenated or trans fats and cholesterol act to reduce this). This fluidity is key to the proper functioning of the membrane-bound and membrane-associated proteins that carry the chemical or electrical signals underlying all information processing in the brain. Certain HUFA – notably AA and EPA - also play key roles as 'second messengers' in chemical neurotransmitter systems, as well as contributing to many other aspects of cell signalling (Nunez, 1993).

Functionally, three HUFA are particularly important in the brain: the omega-6 fatty acids DGLA and AA and the omega-3 fatty acid EPA. In the body these give rise to a very wide range of substances collectively known as the 'eicosanoids', highly bioactive hormone-like substances including prostaglandins, leukotrienes and thromboxanes. These HUFA derivatives can exert profound influences on brain development and function, as they play key roles in regulating blood flow, hormonal systems and immune function. Their effects on the immune system may be particularly relevant to dyspraxia and related conditions, and it is therefore worth noting that while AA's derivatives tend to be pro-inflammatory, the substances produced from both DGLA and EPA have powerful natural anti-inflammatory effects.

In summary, adequate supplies of all four key HUFA (the omega-3 fats EPA and DHA and the omega-6 fats DGLA and AA) are required for normal brain development, and for efficient information processing within the brain and nervous system throughout life. Unfortunately, there are many possible reasons why their availability may be less than optimal, and these will briefly be considered next.

Possible reasons for HUFA deficiencies or imbalances

a) Inadequate dietary intake of HUFA (and/or the relevant EFA)

Oily fish and seafood provide the only significant direct dietary source of the crucial omega-3 fatty acids that the brain needs (EPA and DHA), and this fact supports the traditional wisdom that 'fish is good for the brain'. The 'parent' essential fatty acid of the omega-3 series (ALA) is found in dark green leafy vegetables and certain nuts and seeds (walnuts, pumpkin seeds and linseed (flax) are particularly rich sources), but levels of both ALA and the more important omega-3 HUFA tend to be very low in many modern diets. The dramatic

increase in the ratio of omega-6 to omega-3 fats in our diet over the last century (from around 3:1 to over 100:1 by some estimates) is believed by many experts to present serious health problems, although in reality, it is likely to be the HUFA ratio that matters most. Together with the increase in total fat (particularly from saturated and artificial fats), abundant evidence suggests that a relative lack of omega-3 HUFA may underlie the equally dramatic increase in many 'modern' disorders of physical and mental health, including heart disease and stroke, inflammatory and other immune system disorders (including cancer) and depression (Holman, 1998; Alexander, 1998; Hibbeln, 1998; Horrobin and Bennett, 1999).

The 'parent' omega-6 fatty acid (LA) is very unlikely to be lacking from the diet, as this is found in most vegetable oils. However, as noted above, conversion of EFA to HUFA appears to be inefficient in many people. One of the key omega-6 HUFA, AA, is found in meat and dairy products, so this is also fairly abundant in modern diets (although vegetarians and vegans may need to take steps to ensure an adequate intake). However, an excess of AA in relation to EPA and DGLA - which by contrast are often lacking from the diet - can increase tendencies to inflammation. The only food known to contain significant quantities of the other crucial omega-6 fatty acid, DGLA, is human breast milk; but this fatty acid is very easily synthesised from its immediate precursor, GLA, which is found in some seed oils such as evening primrose, blackcurrant and borage oils. Supplementation with GLA can therefore bypass the initial 'delta-6-desaturase' enzyme step in EFA-HUFA conversion, which is usually the limiting factor.

b) Difficulties in EFA-HUFA conversion

Various dietary and lifestyle factors that can impair the (already limited) synthesis of HUFA from EFA have already been noted earlier, but difficulties in EFA-HUFA conversion can also occur for constitutional reasons. Atopic conditions such as eczema are associated with impaired HUFA synthesis (Manku et al, 1984; Wright and Bolton, 1989), and the same appears to be true in diabetes (Arisaka et al, 1986; Horrobin, 1988). Of particular interest in relation to the excess of males affected by dyspraxia and related conditions is the fact that males are particularly vulnerable to HUFA deficiency, because oestrogen helps to conserve HUFA under conditions of dietary deprivation, while testosterone can inhibit HUFA synthesis (Huang and Horrobin, 1978; Marra and de Alaniz, 1989).

c) Difficulties in recycling HUFA

Other possible constitutional reasons for HUFA deficiencies or imbalances include inefficiencies in the enzymes responsible for recycling them within the brain and body. HUFA are constantly replaced and recycled, both during the normal turnover and remodelling of cell membranes, and in the chemical cascades triggered by normal cell signalling processes. Particular enzymes from the phospholipase A2 (PLA2) group act to remove HUFA from membrane phospholipids, and this creates free fatty acids and other products that are highly vulnerable to destruction by oxidation, and therefore have to be rapidly recycled in at least two further enzyme steps. The efficiency of these processes will differ between individuals, and there is some evidence for both excessive HUFA breakdown and recycling problems in developmental conditions related to dyspraxia, as discussed below.

Features of dyspraxia consistent with fatty acid deficiencies

Difficulties in motor coordination are obviously the fundamental issue in dyspraxia, and evidence from other areas indicates that these are often associated with fatty acid deficiencies. The movement disorders that develop in many elderly people were found to be robustly associated with HUFA deficiencies in a carefully controlled general population study (Nilsson et al, 1996). The same appears to be true of the movement abnormalities in Huntington's disease and those that can result from antipsychotic drug treatment in schizophrenia (Vaddadi, 1996). Furthermore, preliminary evidence shows that treatment with fatty acids may be beneficial in both of these conditions (Peet et al, 2001; Peet and Horrobin, 2002b; Puri et al, 2002), and recent studies have also shown that DHA - one of the key omega-3 HUFA - is particularly concentrated in brain regions involved in motor control.

HUFA deficiencies could also contribute to some of the developmental difficulties in visual processing that are characteristic of dyspraxia. The omega-3 fatty acids are likely to be most relevant here: DHA makes up 30-50% of the retina and when omega-3 fatty acids are lacking from the diet this is replaced by 22:5 omega-6. However, despite the fact that this fatty acid differs from DHA by only one double bond, the effect of this substitution is a dramatic reduction in the efficiency of signal transduction in the retina – the very first stage of visual information processing (Litman et al, 2001). An enormous research literature now testifies to the essentiality of omega-3 fatty acids for other aspects of visual development and function, (Neuringer et al, 1994; Uauy et al, 2001), and deficits in visual selective attention and spatial learning are among the classic consequences of omega-3 deficiency.

With respect to the more general difficulties with attention and arousal that are common in many dyspraxic individuals, the existing evidence for fatty acid deficiencies in ADHD is obviously relevant, and this is considered in the following section. However, in terms of possible mechanisms, it is noteworthy that chronic omega-3 deficiency is associated with reduced levels of dopamine (and its binding to D2 receptors) in frontal cortex (Delion et al, 1994), and this is of course the main neurotransmitter boosted by the stimulant medications used to treat ADHD. Moreover, detailed studies indicate that the reduced storage of dopamine in these regions following omega-3 deficiency may be insufficient to maintain the high release needed during ‘stimulated cognitive processes’ such as sustained attention to a demanding task (Zimmer et al, 1998). Animal studies have also shown that the behavioural effects of n-3 HUFA deficiency include changes in attention, motivation, and reactivity to stimuli and rewards, but not necessarily locomotion (Francàs et al, 1995). This is interesting in view of our own clinical impressions that omega-3 supplements may perhaps have more effect on the ‘attentional’ aspects of ADHD than on hyperactivity per se, although this still awaits confirmation.

Many other features associated with dyspraxia are also consistent with HUFA deficiencies, including:

- *The excess of males affected.* Sex hormones appear to increase vulnerability to HUFA deficiency in males, as noted above.
- *An apparent susceptibility to allergic or autoimmune disorders.* This may reflect constitutional inefficiencies of EFA-HUFA conversion, and would be exacerbated by an excess of AA relative to EPA and DGLA, both of which have anti-inflammatory effects.
- *Disturbances in temperature regulation and sleep.* These are also consistent with a less than optimal balance of eicosanoids (produced from AA, DGLA and EPA), as these help to regulate the hormonal and other systems involved in these functions.
- *Irregularities of mood and arousal.* HUFA can have profound effects on the neural systems governing arousal, and as noted earlier, recent evidence shows that the omega-3 fatty acids – particularly EPA – can help to stabilise mood swings and counteract depression.

Experimental evidence for fatty acid abnormalities in related conditions

Unfortunately, no studies of fatty acid metabolism in dyspraxia per se have yet been reported, although research of this kind is now underway. However, there is already experimental evidence for fatty acid abnormalities in related conditions including ADHD, dyslexia and the autistic spectrum. It is also worth noting that dyspraxia has never yet been ‘factored out’ in these studies, hence many of the participants may have had dyspraxic-type difficulties in addition to their primary diagnosis.

Physical signs of fatty acid deficiency

Mild physical signs consistent with fatty acid deficiency were first reported in connection with ADHD (Colquhoun and Bunday, 1981; Stevens et al, 1995, 1996). These include excessive thirst, frequent urination, rough, dull or dry skin and hair, dandruff, soft or brittle nails, and ‘follicular keratosis’ (a build-up of hard skin around the hair follicles that gives the skin a ‘bumpy’ appearance and feel). Although each of these signs can have other possible causes, their association with fatty acid deficiency has been well-studied in animals; and in children with ADHD, when scored on a simple questionnaire scale their presence and severity has been shown

to relate to HUFA status as assessed via blood biochemical measures (Stevens et al, 1995).

These fatty acid deficiency signs were very marked in the dyslexic boy studied by Baker (1985), and their association with dyslexia has been confirmed in subsequent studies. Ratings of these signs were significantly higher in dyslexic than non-dyslexic adults (Taylor et al, 2000); and within the dyslexic group they were associated with visual symptoms when reading, other visual problems, auditory and language confusions and motor problems.

Their occurrence and severity was also found to correlate with the severity of difficulties with reading, spelling and working memory in dyslexic children (Richardson et al, 2000).

In members of the autistic spectrum, recent studies indicate that these physical signs of fatty acid deficiency are even more prevalent than they appear to be in ADHD or dyslexia (Bell et al 2000, 2002). In dyspraxia, no studies have yet been reported but these are now underway, and clinical experience and anecdotal evidence suggest that the same physical signs will also be associated with this condition. Given that the checklist first developed by Stevens et al. (1995) for rating these signs is a very simple instrument that could potentially be used with minimal guidance by parents, teachers or other professionals, further studies to validate this against objective biochemical measures of fatty acid status are also in progress.

Evidence from biochemical and brain imaging studies.

In ADHD, several biochemical studies have now shown reduced concentrations of HUFA in the blood of ADHD children compared with matched controls (Mitchell et al, 1987; Bekaroglu et al, 1996; Arnold et al, 1994; Stevens et al, 1995, 1996; Burgess et al, 2000).

The most detailed studies (Stevens et al, 1995, 1996) revealed no deficiencies of the 'parent' EFA – either in the blood samples or in these children's diets. This observation is consistent with difficulties in EFA-HUFA conversion, as first suggested by Colquhoun and Bunday (1981), but it would also be explicable in terms of an unusually rapid rate of HUFA breakdown and loss in children with ADHD.

Further analyses of the combined sample of ADHD boys and controls revealed that irrespective of clinical diagnosis, HUFA deficiencies were significantly associated with a range of behavioural, learning and health problems (Stevens et al, 1996). These findings are in keeping with a dimensional view of ADHD, at least with respect to fatty acid deficiencies as a possible contributory factor. Of particular note is that low levels of omega-6 fatty acids were related only to some physical health measures (such as dry skin and hair, frequency of colds, and antibiotic use), but not to parental ratings of behaviour or learning. By contrast, low omega-3 fatty acid status was associated not only with physical signs of fatty acid deficiency (particularly excessive thirst, frequent urination and dry skin) but also with both behavioural problems (including conduct disorder, hyperactivity-impulsivity, anxiety, temper tantrums and sleep problems) as well as learning difficulties in these children. This is consistent with substantial evidence from other sources that the omega-3 fatty acids play a particularly key role in brain function.

Blood biochemical studies of individuals with autistic spectrum disorders have also shown reductions in HUFA concentrations relative to controls in both plasma (Vancassel et al, 2001) and red cell membranes (Bell et al, 2000, 2002). In the latter case, differences did not reach significance in the small number of subjects studied to date, as wide individual variation was observed even within ASD groups separated into 'classical' or 'regressive' autism (according to whether symptoms were present from birth, or developed after the age of 18 months). However, a significant elevation in both groups relative to controls was found in the ratio of AA to EPA, a potential index of 'pro-inflammatory' tendencies. The studies by Bell and colleagues have also revealed that red cell membrane HUFA of individuals with a regressive form of autism are unusually vulnerable to further breakdown during storage unless the blood samples are kept at extremely low temperatures. Possible explanations for this include an excess of a PLA2 enzyme that removes HUFA from membrane phospholipids, as very low storage temperatures are required to inactivate this enzyme. High levels of PLA2 have previously been reported in both schizophrenia and dyslexia (Macdonell et al, 2000), consistent with an unusually rapid

rate of breakdown and potential loss of HUFA via oxidation.

In dyslexia, blood biochemical evidence confirmed the clinical picture of fatty acid deficiency in the case study reported by Baker (1985), but further blood biochemical evidence in this condition is still awaited, as is also the case with dyspraxia. However, in dyslexic adults, brain imaging with cerebral 31-phosphorus magnetic resonance spectroscopy (a non-invasive method of assessing the chemical composition of brain tissue) has revealed anomalies of membrane lipid turnover that would be consistent with HUFA deficiency (Richardson et al, 1997).

Can dietary supplementation with highly unsaturated fatty acids help?

The suggestive evidence for HUFA deficiencies or imbalances in dyspraxia and related conditions has raised the possibility that dietary supplementation with HUFA might be of some benefit. Anecdotal evidence suggests that this is true in at least some cases, but carefully designed and properly controlled studies are needed to establish whether or not this is really the case. Randomised, double-blind, placebo-controlled trials are regarded as the 'gold standard' in this respect: participants are allocated at random to either the treatment under study or a placebo, and no-one is permitted to know which treatment any individual is receiving until all study data have been collected and verified. While controlled trials of this kind remain the only reliable way to eliminate the influence of expectations, they do have their limitations (Slade and Priebe, 2001). They are most suited to evaluating single treatments for physical medical conditions involving clear diagnostic criteria and homogeneous study populations. They are much less suited to behaviourally-defined developmental conditions such as dyspraxia, dyslexia, ADHD or the autistic spectrum (or any psychiatric conditions), where the causes are likely to be complex and multifactorial, and standard diagnostic criteria will identify a very heterogeneous population.

In ADHD, several controlled treatment trials have been reported to date, with somewhat mixed results. The first such studies involved supplementation with evening primrose oil, supplying the omega-6 fatty acid GLA, and these indicated only marginal if any clear benefits (Aman et al, 1987; Arnold et al, 1989). However, mounting evidence now indicates that omega-3 fatty acids are likely to be more important than omega-6 in their effects on behaviour and learning, and these are also more likely to be lacking from modern diets.

In another randomised controlled trial of fatty acid treatment in ADHD children, a supplement of fish oil and evening primrose oil was therefore used, supplying mainly the omega-3 fatty acids (EPA and DHA) as well as a little omega-6 (GLA and AA). An early report of this study indicated blood fatty acid changes in the treated children that were associated with reduced ADHD symptoms (Burgess, 1998), but a full publication of the results has not yet appeared at the time of writing. Meanwhile, supplementation with DHA alone was recently found to be completely ineffective in ADHD (Voght et al, 2001). These findings are consistent with other evidence that EPA, not DHA, is the important omega-3 fatty acid for improving attention and mood and reducing perceptual or cognitive disturbances, as discussed further below.

In dyslexia, several randomised controlled trials have now been carried out involving both children and adults, although only one of these has so far reached full publication (Richardson and Puri, 2002). This was a small pilot study involving dyslexic children from a special school who also showed features of ADHD, although none of them had a formal ADHD diagnosis. Results showed that compared with placebo treatment, HUFA supplementation for three months led to significant reductions in attentional problems, anxiety, and disruptive behaviour as assessed by the Conners' Parent Rating Scales (CPRS-L). When the placebo group were then given HUFA supplementation (without the children or their parents and teachers being aware of the switch) they showed a similar reduction in ADHD-related symptoms over the next three months, in stark contrast to their earlier lack of improvement on placebo (Richardson et al, in preparation). In a different, larger study of clinic-referred dyslexic children, preliminary results suggest that HUFA treatment may also improve reading progress (Richardson et al, in preparation). Full analyses of the data from this trial are still in progress, but treatment effects seem to be particularly pronounced in children showing either physical signs of fatty acid

deficiency or visual symptoms before treatment.

As yet, there have been no properly controlled trials concerning either dyspraxia or the autistic spectrum. One small open study of dyspraxic children has been reported, involving supplementation for three months with both omega-3 and omega-6 HUFA from a combination of fish oil and evening primrose oil (Stordy 2000). Reductions were found in both motor difficulties (as assessed via parental report and the Movement ABC) and ADHD symptoms (as assessed by the Conners Parent Rating Scales). However, without a placebo control group it is not possible to ascribe these changes to the treatment itself, as expectations can obviously play a significant role.

The first randomised, double-blind, placebo-controlled trial of HUFA treatment in dyspraxic children is now underway, involving 120 children aged 8-12 years. Measures of motor function, visuomotor skills and ratings of ADHD-related features are being assessed before and after treatment with either a HUFA supplement (containing 80% high-EPA fish oil and 20% evening primrose oil, supplying mainly omega-3 but some omega-6 HUFA) or a placebo (containing olive oil, and carefully matched for both appearance and flavour with the active treatment). This study also includes a new biochemical measure in the form of a 'breath test' designed to measure levels of ethane, the final breakdown product of omega-3 fatty acids (Ross, 2002). High levels of expired ethane would suggest that these fatty acids are being lost more rapidly than usual (rather than being recycled), and the breath test may therefore help to identify those individuals who may need a higher dietary intake of these key fatty acids.

In summary, only a few properly controlled trials of HUFA supplementation in ADHD and dyslexia have yet been carried out. The balance of evidence suggests that this may have benefits in at least some cases, but differences in the populations studied, the supplements used, and the outcome measures as well as the trial designs make clear interpretation difficult. Many of these early studies have involved only small numbers of participants – and while this obviously makes generalisation difficult, it also means that much larger treatment effects are required in order to show statistically significant group differences. Further studies are therefore needed, but given the heterogeneity within dyspraxia and related conditions, a focus on subsets of individuals defined by specific features - rather than these broad diagnostic labels - may be the most fruitful approach.

Practical guidance

As noted above, there is not yet any firm evidence that dietary supplementation with HUFA is beneficial for dyspraxia. However, as a result of increasing public awareness and the many positive anecdotal reports that have been circulating both within support groups and via the media, many people are already trying this approach for themselves. Unfortunately, accurate information on how to go about this is often lacking, and there are actually many important factors to consider.

First, prior consultation with a medical practitioner is always advisable before taking any food supplement, and this is clearly essential for anyone undergoing medical treatment or supervision. If possible, guidance from a well-qualified nutrition practitioner is also recommended, as there may well be other aspects of diet that require attention. Dietary and lifestyle changes alone can substantially increase the availability of HUFA, although if individual needs are unusually high then supplements may be the only practicable option. It must also be firmly emphasised that this approach cannot be expected to help every individual with the 'dyspraxic' label. However, provided that some basic precautions are taken, HUFA supplements are very unlikely to do any harm, and furthermore, they are already known to have a wide range of general health benefits. The only known negative effects involve mild digestive upset, although this is relatively uncommon and can usually be minimised with attention to other aspects of the diet.

Choosing Supplements

It is crucial to recognise that although many different fatty acid supplements are available, these vary widely in

both their composition and their quality. With respect to quality, it is an unfortunate fact that some fish and fish oils may contain pollutants such as mercury, PCBs or dioxins. Furthermore, the quality (and therefore the efficacy) of both omega-3 and omega-6 oils is also affected by the methods of manufacturing, processing and storage used. In brief, they are destroyed by exposure to light, heat or air; but see Erasmus (1993) for a full and extremely readable explanation of the implications of this for the manufacturing of all fats and oils, as well as the importance of omega-3 and omega-6 oils for general health.

Information on quality and safety issues should therefore be obtained from an independent source before choosing any supplement, and at the very least, it should not be assumed that the cheapest supplements provide the best value. With respect to the composition of supplements, several points are relevant:

- 1. Omega-3 HUFA appear more relevant than omega-6 to these developmental conditions, and these are also the ones more likely to be lacking from modern diets.** The 'parent' omega-6 EFA (LA) is plentiful in most vegetable oils, and the important omega-6 HUFA AA is supplied directly by most meat and dairy products. However, if EFA-HUFA conversion is inefficient there may still be a relative lack of the omega-6 fatty acid DGLA. If so, additional evening primrose oil to supply GLA (easily converted to DGLA) may be warranted.
- 2. Within the omega-3 HUFA, the latest research indicates that it is EPA, not DHA, that is likely to be most effective.** Both are essential for optimal brain function, but while DHA is important in brain *structure* (hence adequate supplies are particularly needed during early brain development), EPA is important for the moment-by-moment regulation of brain *function*. Substances produced within the body from EPA are crucial for regulating immune function, hormonal balance and blood flow, which can all affect brain function as well as many other aspects of health. Pure DHA has been found ineffective in treating both depression and schizophrenia, while pure EPA has shown significant benefits in these conditions (Peet et al, 2001; Peet and Horrobin 2002a,b). Pure DHA was also found to be completely ineffective in reducing ADHD symptoms (Voigt et al, 2001), while preliminary evidence suggests that supplements containing both EPA and DHA may help to do this (Burgess, 1998; Richardson and Puri, 2002). Standard fish oils contain both EPA and DHA in ratio of around 3:2, but supplements containing higher proportions of EPA are now available.
- 3. Fish liver oils are not suitable for these purposes** owing to their high Vitamin A content, and any HUFA supplements for which premium quality cannot be guaranteed should also be avoided. These may not only be ineffective, but could contain harmful residues (from environmental pollution or from extraction and processing methods), as noted above.
- 4. Antioxidant intake should be considered**, because HUFA are particularly susceptible to breakdown via oxidation. Supplementation with Vitamin E in particular can help to protect them, and a good intake of this and other antioxidants is advisable.
- 5. Vitamin and mineral intake is important.** Essential co-factors for the synthesis of HUFA from EFA include zinc, magnesium, and vitamins B3, B6 and C among others. These and other vitamins and minerals are required in any case for the proper functioning of the brain and body, but available evidence indicates that many individuals do not receive an adequate intake of these essential micronutrients. These should ideally be obtained from the diet, but could also be provided by a multivitamin and mineral supplement if required..
- 6. Other aspects of diet may also merit attention**, and this may well be the best place to start. Advice from a well-qualified nutrition practitioner may be useful, as well as consulting with the GP (which is essential if any serious allergies or food intolerances are suspected). However, some sensible basic steps for most people would include:
 - eating plenty of fresh fruit and vegetables, nuts and seeds, fish and seafood and unrefined carbohydrates (i.e. those found in whole grains and vegetables);

- drinking plenty of water (and avoiding too much tea, coffee, or drinks that contain caffeine or other stimulants);
- reducing the intake of saturated fats (particularly from fried foods), and avoiding highly processed foods with artificial fats (hydrogenated and 'trans' fatty acids);
- cutting down on sugar and refined starch (i.e. non-wholemeal bread, cakes, pastries, biscuits, sweets and soft drinks, which often have a high sugar content and/or artificial sweeteners, which may also be best avoided);
- If food allergies or intolerances are suspected, it may also be worth exploring these, preferably with professional assistance. Some people have difficulties in properly digesting wheat and/or dairy products, so removing these from the diet can be very helpful in some cases.

Dosage, duration, and monitoring of response

Dietary HUFA requirements will differ between individuals and can also differ in the same individual over time, as they will depend on other aspects of diet, stress levels or illness, among other things. Optimal dosage is therefore best determined from careful monitoring, with attention paid to any changes in other factors that may be relevant.

In our ongoing studies of dyslexia and dyspraxia, a high-EPA fish oil supplying 500mg EPA daily is used. However, it is clear that some individuals may need more than this (particularly those with severe mood swings, emotional sensitivity and/or behavioural problems such as temper tantrums). It may be relevant that recent studies have found doses of 1g/day of EPA or more to be effective in reducing symptoms of depression (Puri et al, 2001, 2002a; Peet and Horrobin, 2002; Nemets et al, 2002), and daily doses of 2-4g pure EPA have been used successfully in disorders such as schizophrenia and bipolar (manic depressive) disorder (Puri and Richardson, 1998; Puri et al, 1999; Stoll et al, 1999; Peet et al, 2001, Peet and Horrobin, 2002).

As discussed above, supplementation with omega-3 fatty acids appears to be more important than omega-6 for these purposes, but an adequate supply of both series is always needed. If an omega-6 source is to be included (which it is in the supplement used in our developmental studies), then evening primrose oil supplying 50-100mg of GLA daily should generally be sufficient, although more may be helpful for individuals who also suffer from atopic conditions such as eczema.

It is very important to recognise that HUFA are foodstuffs and do not act as rapidly as most medications, so any effects will take time to appear. In our experience, most individuals who respond to supplementation usually report noticeable benefits within one or two weeks, but in other cases changes seem to be more gradual. The minimum trial period should be at least three months, as studies have shown that it takes 10-12 weeks for HUFA levels in brain cell membranes to return to normal levels after a long-standing deficiency (Bourre et al, 1988).

After a few months, reducing the initial dose to half or even one-third of these levels may be possible without loss of benefits, but we have found that many people appear to need high levels on a long-term basis to prevent symptoms from re-appearing. Any dose changes should be made as systematically as possible, and the effects monitored for at least 1-2 weeks before further changes are made.

Predicting the response to HUFA supplementation?

Given the variability that exists within dyspraxia and related conditions, fatty acid supplementation cannot be expected to benefit more a subset of affected individuals, and many people who consume a balanced and healthy diet will already be obtaining all the HUFA they need. Nonetheless, some possible indicators of a good response to HUFA supplementation have emerged from our clinical experience and research to date, and these include the following features:

- Physical signs of fatty acid deficiency (excessive thirst, frequent urination, rough or dry skin and hair, dandruff, and soft or brittle nails)
- Atopic 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 (including distractibility, difficulties with sustained concentration, working memory problems and feelings often described as like 'brain fog')
- Emotional sensitivity or lability (especially undue anxiety/tension, excessive mood swings, or temper tantrums arising from 'low frustration tolerance')
- Sleep problems (particularly if these involve difficulties in both falling asleep at night and waking up in the morning)

Further research is still needed to establish which of these features – if any – may respond to dietary supplementation with HUFA, but results from controlled trials in both dyspraxia and related conditions should help to elucidate this. It must also be emphasised that nutritional intervention is obviously only one aspect to consider in the management of developmental dyspraxia. Other interventions and most important of all, understanding, appropriate support and encouragement, are likely to be needed for dyspraxic individuals to achieve their full potential.

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RESEARCH ARTICLES

Published Research into Dyspraxia / Developmental Coordination Disorder

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- For book references give the name and initial of the author/s, editors, year of publication, title of the book, publisher, place of publication, and the chapter number or the page number of the citation. e.g. Portwood M (2000), Understanding Developmental Dyspraxia - A Textbook for Students and Professionals, Fulton Publishers, London, ch. 2
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A look at Current Games on the market suitable for the Dyspraxic Child

By Gavin Ucko

Managing Director of The Happy Puzzle Company.

Perhaps one of the most difficult aspects of dealing with a situation where a child has just been diagnosed as being dyspraxic is in fact dealing with the anxious parents, who seem racked with guilt and have little understanding of what being dyspraxic means.

Often, in their perception, there is 'something wrong' with their child. Most parents are willing to entrust improving the situation with an OT, Physiotherapist or support teacher. However, given the correct tools, almost every parent will be only too happy to try out some 'home' activities that could really benefit their child.

What many parents don't see, is that some of the most up-to-date toys and games, that any child would want, will, in fact, be full of hidden qualities that can assist with a learning difficulty.

It is our job to provide parents, teachers and OT's, with fun, stimulating activities, which when played with, will require using the very skills that will assist the dyspraxia.

These games are not necessarily the magic solutions that so many parents want, but if a child can sit with their parents or siblings, or even alone, and take pleasure in solving a puzzle or tackling a challenge that will improve hand / eye co-ordination, fine motor control or sequencing skills, then surely that can only be a good thing.

Over the coming issues, I would like to try and highlight some of the puzzles and games that we supply, that will be of great use to any dyspraxic adult or child, and which will prove useful for any OT, parent, physiotherapist or teacher, in working with dyspraxia.

We'll start with a look at Rush Hour, winner of the Toy of The Year award and a thoroughly effective way of improving fine motor and sequencing skills. The aim of the game is to manoeuvre a series of 3-D cars and lorries backwards and forwards on a grid until your own red car can escape from the traffic jam. Great fun and highly addictive, being suitable for ages 8 and up, there is also a junior version (ages 6 to 8) and larger versions (Railroad Rush Hour, Safari Rush Hour) which are much bigger, and more importantly, have bigger pieces to grip, as well as puzzles for all age groups. Each game has at least 40 puzzles.

A great feature of the Rush Hour series is that the games are graded. Many other games in our range are also graded, making them ideal for building confidence. Success with the easier puzzles will encourage perseverance with the harder ones and will also lead to a great feeling of achievement. Sequencing games such as Hoppers (based on peg solitaire), Lunar Lockout, Flip-It and Leapin' Lizards fall into this category.

Shape, By Shape, Block By Block and Brick By Brick are highly effective at developing spatial awareness and co-ordination in both 2 and 3 dimensions, whilst trying to balance a series of 24 penguins on a floating iceberg is highly effective for the development of hand-eye co-ordination and is also a great family game.

Finally, let me mention the superb colour sequencing game Tantrix which is one of the most effective sequencing games that we have seen for the whole family to play. Its brilliance is in its simplicity, and whilst you have probably never heard of it, there is even a Tantrix world championship!

All of the games mentioned are available from The Happy Puzzle Company. For further information please call Freephone 0800 376 3727 or visit www.happypuzzle.co.uk.

**Abstracts for papers and posters accepted for the Professional Conference 2002 at
Brighton on September 13/14**

Paper presentations

Title: **Tension, Anxiety and the Assessment and Treatment of Dyspraxia
Patricia Sims MRCSLT,
*The Nethercott Practice, Braunton, Devon***

This paper is based on empirical observations made during twenty years of clinical experience in all types of establishment. It suggests a new direction for research and a new light in which to consider assessment and treatment of dyspraxia.

Tension and anxiety are attributes of us all and are necessary to our existence and development. However, even when they are at normal, acceptable levels inherent tension and anxiety can cause problems in development. When children's personality traits which can be related to tension or anxiety are considered, utilising a comprehensive personality checklist, it becomes clear that the traits overlap throughout a variety of learning difficulties, and help to decide their diagnosis.

The role played in dyspraxia by a young child's tension or anxiety, and related inattention and poor kinaesthetic and spatial awareness, are discussed in relation to the early programming of unrefined or dyspraxic motor responses which persist as a person's norm.

It is shown that in order to properly appreciate the nature of dyspraxia, an overall look at children's learning difficulties needs to be taken with some comprehensive research into the role played by tension and anxiety through traits. The various symptoms of dyspraxia are viewed in the light of tension and anxiety. The male : female ratios given for dyspraxia and other learning difficulties are addressed.

The relevance to treatment is discussed.

Title: **Differences between dyspraxics and dyslexics in sequence learning and working memory.**
Jeffries, SA & Everatt, J
University of Surrey, Guildford

Dyspraxics and dyslexics, who have co-ordination and linguistic difficulties respectively, often have problems with sequence learning and working memory. This study investigated differences and similarities between the two groups in these areas. Ten dyspraxics, 11 dyslexics and 23 controls participated. All were past secondary education, with ages ranging from 16 to 66 (mean age 28 years). Males comprised 25% of the sample. The initial six tasks confirmed specific learning difficulties. Five sequencing tasks assessed working memory by requiring the immediate recall of audio, visual, spatial and visual-spatial stimuli, via a verbal or motor response. On visual, spatial and visual-spatial tasks with motor responses, the dyspraxic group's performance was the worse of the three groups, whereas the dyslexic group achieved the highest test scores. However, dyslexics were the poorest group in the auditory/verbal tasks, with the dyspraxic group producing the highest average scores. Phonological versus visual-spatial difficulties appeared to affect performance in sequence tasks, suggesting that different rehearsal subsystems of working memory may be impaired accordingly and that these groups may experience problems with literacy learning for differing reasons. Conversely, dyslexics may have

good visual/spatial abilities whereas dyspraxics appear to have good phonological ability. Such findings have implications for assessment and remediation techniques. Looking for specific dyspraxic deficits that affect learning and linguistic skills as well as dyslexic deficits. Multi-sensory remediation could be used to emphasise the phonological and visual-spatial abilities of dyspraxics and dyslexics respectively, thus balancing subsystem components of working memory and enhancing rehearsal strategies to prevent information decay.

Title: Developmental Co-ordination Disorder in preterm children born \leq 32 weeks gestation age

*Foulder - Hughes Local Anaesthesia PhD Med Dip COT, Cooke RWI
Institute of Child Health, University of Liverpool.*

This study aimed to discover whether children who were born very preterm. <32 weeks gestational age, are at an increased risk of developmental co-ordination disorder (DCD), when compared to children born at full term. The preterm cohort consisted of children who were born in the Liverpool postal code region during 1991 - 1992, who were at mainstream school, followed up at age 7 or 8 years. Children were assessed alongside age, sex and class mate control children, who were born at full term > 37 weeks. A total of 280 preterm subject children, and 210 controls were assessed. Motor function was assessed using the Movement SBC, (with 5th %ile used as a cut off point to define DCD), the VMI to test visual motor integration function and the WISC III-R UK, to screen intelligence levels. There were highly significant statistical differences between the subject and control groups on all of the standardised assessments ($P=<0.001$). The incidence of DCD in the preterm group was 30.7% ($n=86$), compared to 6.7% ($n=13$) in the control population. Total, verbal and performance IQ results were lower in the preterm group ($p=<0.001$), however, there was a correlation between poor fine motor skills and problems with visual motor integration and performance IQ scores and ultimately total IQ. Our research has demonstrated that preterm children are significantly more likely to develop DCD and associated performance and intelligence difficulties, than children who were born at full term. The difficulties may ultimately affect school performance and activities of daily living, so further research is required into the benefits of suitable intervention.

Poster Presentations:

Title: The improvement made with self esteem following physiotherapy Treatment for Dyspraxia.

*Michele Lee MCSP SRP, Sue Yoxall MCSP SRP, Polly Smith BSc OT
The Lee Medical Practice, Denham, Buckinghamshire*

This poster considers the vital role self esteem plays a vital role in the development of a child. The importance of self esteem has been discussed by many authors in relation to the influence it has on intellectual, social and gross motor movements (Laszlo & Bairstow (1985), Lee & French (1994) and Portwood (1999)). There have also been reports on the effects of poor self esteem as a result of failure leading to truancy and in some cases delinquency (Chu 1998, Lee 1998, Portwood 1996, 1998, 2000).

Several authors have commented on the subjective improvement noted by parents and professionals on children's self esteem following treatment (Lee & French 1994, Addy 1996, Portwood 1996 and Lee & Smith 1998). However, to date there has been very little evidence using objective testing to prove these subjective findings.

The authors completed a study of 25 children with a diagnosis of Dyspraxia or Developmental Co-Ordination Disorder using the B/G Steem to ascertain the level of self esteem prior and following treatment. Results show

that initially, 46% of the study group had scores that were considered to be low to very low prior to treatment. 35% showed normal scores and 19% showed high scores.

To date there have been 18 completed treatment programmes and these children have also completed the B/G Steem score sheets again. Each child has made a mean improvement of 3.6 points (scores have ranged from 1 – 10 points) with no child not making an improvement. These scores have placed all the children's self esteem scores with in the normal to high category.

The authors are confident that further results of the remaining 7 children will to show similar improvement.

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