Neurofeedback: An approach to reducing negative behaviours exhibited by students with autism.

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RUNNING HEAD: Neurofeedback: An approach to reducing negative behaviours exhibited by students with autism.

Abstract:

Recent research has specified that there are different brainwave patterns occurring in students with autism. These brainwave patterns are indicative of negative behaviours that may impact severely on functioning levels. This article describes neurofeedback training as a means of reducing these behaviours. Such training has been occurring in clinical settings in the USA, UK and with two known practitioners in Australia. The school (Hervey Bay Special School) elected to explore the benefits to be gained within an education setting through the establishment of a pilot study. Six students undertook a program of 3x20minute sessions a week for one semester. The results identified a reduction in negative behaviours within a range of 2.2% to 47.8% as measured by ATEC assessment criteria. The student's cognitive skills and readiness to learn have been greatly enhanced with indications supporting the long-term effects of EEG changes. This school is believed to be the first school in Australia to trial neurofeedback.

Background:

Neurofeedback has its beginnings in the early sixties when Sterman and his research team (Robbins, 2000), discovered that by using operant conditioning and electroencephalograph (EEG) feedback, individuals could strengthen their brain function and control their brainwaves.

Remarkable results were achieved in reducing seizure activity (Jarusiewicz, 2002) (Robbins,2000). Further research, along with that conducted by Perl (2002) who collected data over a three year period from cases within his private practice, has identified improvements in the symptoms of ADHD and autism (Jarusiewicz, 2002), as well as having positive outcomes for the treatment of head injuries; sleep disorders, addictions, strokes and depression (Robbins, 2000).

Consideration of neurofeedback for students with autism:

Jarusiewicz (2002), in her study to determine the efficacy of neurofeedback for children in the autistic spectrum and others identified improvements in symptoms and behaviours of those students who had undergone neurofeedback training. Current research (Robbins, 2002) identifies through brainwave tracings that there are some characteristic brainwave symptoms associated with autism. Darling (2004) suggests that problems of gut function and metabolism that are common in children with autism might contribute to abnormal neurotransmitter synthesis. This in turn may have an effect on brainwave activity. Students with autism tend to have over aroused nervous systems (Darling, 2004) as indicated by elevated hi-beta levels. Training the amplitudes of hi-beta brainwave to decrease means the individual may

experience a calm state. Once in this state, the students' school review reports (Davies & Treuel, 2004) revealed improvements in such diverse areas as reducing anxiety, hyperactivity, sensory sensitivity, toileting difficulties and increasing positive social interactions, attention, and communication. Students were engaging in the learning process and improved learning outcomes were occurring.

Motivation for the project:

The Neurofeedback program at Hervey Bay Special School was proposed at the end of 2003 as an innovative response to meeting the needs of students with autism. The proposal was motivated by one of the main findings of the Triennial School Review (2001-2003) which stated that ' … the admission of students with autistic spectrum disorder in the last year have increased considerably. The implications for the school are ones of classroom space and expertise of school staff in dealing with students with autism who often exhibit challenging behaviours.' This finding coincided with a seminar attended by staff members on EEG Neurofeedback run by a psychologist and neurofeedback clinician from the Sunshine Coast. The response from this seminar was very positive and led to information days with staff and parents where a determination emerged to trial the approach at the school. Neurofeedback was to be explored to determine if it would be a positive addition to the toolkit of intervention programs already operating within the school.

The approach is driven by the acceptance that autism is a very complex neurological disorder (Howlin, 1998**)** that is fast becoming better understood. In the light of the *new brain sciences*, (Organisation for Economic Co-operation and Development OECD Report, 2002) teachers are able to merge these understandings with more effective intervention strategies.

Project establishment:

A neurofeedback clinician conducted in-service sessions on staff development days at the start of 2004 and collaboratively the staff designed the structure for this pilot study. This included the allocation of school financial and human resources to purchase a “BrainMaster” system, negotiation of a consultancy fee with the supervising clinician, appointment of a school co-ordinator and the rearrangement of classroom loads.

Group of Students Selected for the Pilot Study:

The size of the pilot study was determined as six students that would enable six forty-minute sessions to be allocated in one day. The recommended number of sessions is 3 a week and the normal recommended length of treatment is between 20 and 40 sessions.

The six students were chosen from a cohort of 18 students at the school who had a diagnosis of Autism and had been ascertained as having the highest level of support needs (Level 6). The whole staff was involved in the selection process which looked to spread the selection across six different classes so that six teachers could be involved. Refer to Table 1 that provides an outline of student characteristics. Other criteria ensured that there was a spread across the autistic spectrum, involving different ages and different challenges.It was imperative that the parents were supportive and prepared to be involved in the monitoring and assessment process.

Name	Gender	Age	Diagnosis	Main Goals	
NF	M	12.1	Asperger's Syndrome ASD 6	Neurofeedback	To reduce anxiety and seizure activity
				IEP	To improve co-operative and social skills.
KS	M	15.6	Asperger's Syndrome ASD 6	Neurofeedback	To reduce impulsivity and increase attention.
				IEP	Develop skills in time management and in dealing socially with his peers.
DS	M	10.10	Autism Congenital Myopathy ASD / II 6 PI 4	Neurofeedback	To reduce impulsivity and agitation.
				IEP	To stay on task for 5 minute periods
NA	M	14.7	Autism XYY Syndrome ASD 6	Neurofeedback	To reduce anger and irritability
				IEP	Will accept correction from staff
TD	M	16.1	Autism ASD / II 6	Neurofeedback	To reduce impulsiveness, agitation and obsessiveness.
				IEP	To follow two step instruction.
BP	F	8.9	Autism ASD / II 6 PI 4	Neurofeedback	To reduce hyperactivity, obsessiveness and increase attention.
				IEP	To communicate needs and wants appropriately.

Table 1: Student Characteristics

Description of a Neurofeedback Training Session:

Using EEG equipment, digitised brainwaves are collected by electrode leads that are attached to the student's scalp and are projected onto a computer screen in a game-like form. The student attempts to use feedback to achieve a specific goal of EEG change by learning to maintain a certain 'mental state.' The 'calm but alert' mental state, and associated protocols, was targeted for all the students on the pilot study. The training session requires the student to keep a 'Pac-man' moving solely by developing a more normal brainwave pattern. In order to do this the student watches three thermometers. Figure 1 shows a student engaged in the program. Information is given visually with the student requiring to reduce or increase the

frequency of a specific wave. A reward is given via the 'Pac-man.' Over a series of sessions the ease of maintaining this correct state usually increases.

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Results of sessions are emailed through to the neurofeedback clinician who interprets and makes appropriate changes to the protocol settings. Figure 2 illustrates a printout example of these results. New settings are then emailed back to the school. The student accesses the new settings in next training session.

An example of a read-out:

Reporting EEG Progress – All Sessions

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Report on the Outcomes:

<u>The Autism Treatment Evaluation Checklist (ATEC).</u>

The assessment device used at the start and end of the project was Rimland's (2000) Autism Treatment Evaluation Checklist (ATEC). This checklist was designed by the Autism Research Institute to measure the usefulness of various treatments. It is a questionnaire for parents and teachers. It is easy to use and can be scored instantaneously on the Autism Research Institute's website. This assessment looks at four main areas of autistic behaviors. These are communication, social skills, sensory/cognitive awareness, health and physical behaviors. Table 2 summarizes pre-test/post-test scores from data collected from parents and teachers and gives a quantitative measure allowing comparisons.

Table 2 **ATEC - PRE-TEST / POST-TEST COMPARISON**

		Speech Language Communication		Sociability		Sensory /Cognitive Awareness		Health / Physical Behaviour		Total	
STUDENT		**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
NF	**Parent**	1	3	21	9	12	8	43	33	77	55
	Teacher	0	4	7	8	4	6	31	19	42	37
KS	**Parent**	0	1	28	21	14	12	43	43	85	77
	Teacher	2	4	8	11	6	14	24	21	40	50
	Parent	6	7	19	12	19	16	24	15	68	50
DS	**Teacher**	9	5	12	8	15	14	22	19	58	46
	Parent	5	4	14	11	17	12	27	18	63	45
NA	**Teacher**	1	1	10	9	1	8	14	7	26	25
	Parent	16	17	31	23	21	25	12	12	80	77
TD	**Teacher**	20	15	19	5	18	12	8	14	65	46
	Parent	17	19	22	6	23	21	44	35	106	81
BP	**Teacher**	19	19	23	8	28	19	44	26	114	72

Table 2: Summary of ATEC results.

The treatment program initially targets one or more of these areas for each student. When interpreting the results a lower score indicates a reduction in negative behaviours. The lower the score the less the impairment is said to be impacting on behaviours. Neurofeedback training resulted in a decrease of ATEC rated symptoms ranging from 2.2% to 47.8%.

Whilst the ATEC assessment was to be the benchmark for the complete program it was soon evident that its lack of precision would not register short-term changes. More finely calibrated checklists were formulated to record these and provide acceptable data for the short term. Specific communication sample testing was designed by the school's Speech Language Pathologist to assess progress in that area and checklists were administered by teachers post session in social behaviors and sensory cognitive awareness. Elder's (2004) Behavioral Rating Scale for Neurofeedback Training (BRSNT) proved to be effective in recording progressive

changes and became in effect the main assessment device, with the ATEC used at the end of the project. JD Elder, a neurofeedback clinician operating within the U.S.A. education system devised this checklist to measure the frequency of negative behaviours and monitor the change of the behaviours. This was a quick assessment to administer and indicated when consolidation of the program was established. It should be noted however that BRSNT is not a reliable instrument and interpretation of results should take this into consideration. None-the -less we found it to be useful along with observation and feedback from parents and teachers. Evaluations of Individual Education Plans (IEP) were seen as an important adjunct to the assessment of outcomes and they were reported through the traditional format of testing and observation in the classroom setting.

IEP Outcomes:

Of the six targeted IEP goals (one per student), teachers rated achievement levels on a scale from none --- some --- significant --- marked. Two students were rated as significant, two students were rated as some, and two students were rated as none.

Anecdotal Comments

The behavior management/guidance officer reported that KS was showing marked improvement in turn taking at their weekly group meeting. The principal reported that incidents of aggression with NA (previously frequent) were of much lesser frequency and intensity. The teacher aide in NF's class stated that he was far less anxious. Teacher in NF's class reported a marked improvement in Maths. DS's parents reported an increase in

concentration but also a marked increase in awareness of his surroundings necessitating greater supervision.

Parents and class teachers administered the BRSNT over six sampling periods. This scale measures the frequency of selected negative behaviours (symptoms of autism) over the training period. Table 3 summarizes the observed changes in negative behaviours. Four students showed marked improvement over a period of four months. One student showed a notable improvement whilst one showed some improvement. In the case of the latter it was interesting to note that improvement was shown in the area of sleep patterns as reported by his mother. KS was now sleeping from 10pm through to 6 am with less wakeful episodes in comparison with sleep patterns before coming onto the program. The frequency of epileptic seizures in NF and DS were less frequent than before program commencement. BP and TD increased functional communication utterances.

Summary of Changes in Negative Behaviours

Name	*Number of Sessions*					
	4	*10*	*16*	*20*	*23*	*28*
NF	131	175	48	32	26	20
KS	210	205	201	179	173	152
DS	152	104	78	71	40	22
NA	91	72	69	50	42	38
TD	137	84	65	56	49	33
BP	169	125	93	69	59	48

Table 3: Behavioural rating scale for neurofeedback training

Discussion:

The pilot study at the end of the first semester 2004 has run it's projected course of forty sessions. The collated data identified that the program effects changes in a range of behaviours with a reduction in negative behaviours within a range of 2.2% to 47.8% as measured by ATEC assessment criteria.

There were a number of variables that could not be separated from the intervention. These included the suspected use of recreational drugs, severe delinquent activities involving the police, a relationship break-up and a serious family illness.

It was noted during the project that some of the negative behaviours were determined to be the result of the interaction between a calming mental state and continuing doses of stimulatory medication, i.e. Ritalin. A reduction in medication led to improvement, which emphasised the importance of medical overview and co-operation.

Discussion with the consultant neurofeedback clinician highlighted an important difference between a clinical setting and the school environment. The one-to-one clinical setting enabled instant modification of frequencies because of instant feedback. The gathering of information from teachers and parents proved to be time consuming due to such things as questionnaires not being handed in on required date and constraints of other demands. Therefore there is a lag in the changing of frequencies and scalp placement. Without a trained neurofeedback clinician on site this problem needs to be managed with further discussion and may involve a slower and longer period of treatment.

It became apparent, during the course of the project, that the measurement of changes posed a serious challenge and that a range of finely calibrated instruments would have been useful. What was initially seen as the main instrument in determining change (ATEC) was shown to be rather cumbersome and unsuitable for monitoring short-term changes. We were fortunate in receiving at an early stage a checklist from an experienced practitioner in the U.S. that indicated the changes we were looking to measure, in a quantitative way. The BRSNT became our main recording means of change. Some students' results were better than others, which may be because of the previously mentioned variables. However it may be that some students require a greater number of sessions than the recommended 40 sessions for ADHD children because of the range of behaviours that autism encompasses and because of the lack of an onsite neurofeedback consultant who can make instant changes to the protocol settings.

Anecdotal and IEP reports supported parts of the results although it was informative to see changes being viewed negatively mutually by both teachers and parents. Later discussions with parents and teachers reframed these changes as positive. One student, regarded as severely autistic, commenced testing his parent and teachers tolerance by running away from home and class. When viewed with such changes as an increase in functional communication skills, it became evident that a new world of 'exploration' had opened up to him. With this in mind teacher and parent were able to change their approaches to accommodate the new behaviours.

Future Direction:

This Pilot Study has been a program that has been able to identify encouraging changes in student behaviour. Some other noteworthy developments have been in the knowledge base of school staff and the increasing recognition of neurology and its relationship to human behaviour and disability. Funding sources are being sought to continue this program into the next semester where it is hoped to expand the team's experience and avoid some of the pitfalls that were encountered. The access to expertise outside of the education community and a partnership with an experienced and knowledgeable neurofeedback consultant was both essential and rewarding. Interest has been shown locally in trialling the program with students with other behavioural difficulties.

In February 2005 Hervey Bay Special School was presented with a National Award for Quality Schooling in the category of Outstanding National Achievement for Neurofeedback: An Approach to Reducing Negative Behaviours Exhibited by Students with Autism by the Honourable, Dr Brendan Nelson, Minister for Education, Science and Training.

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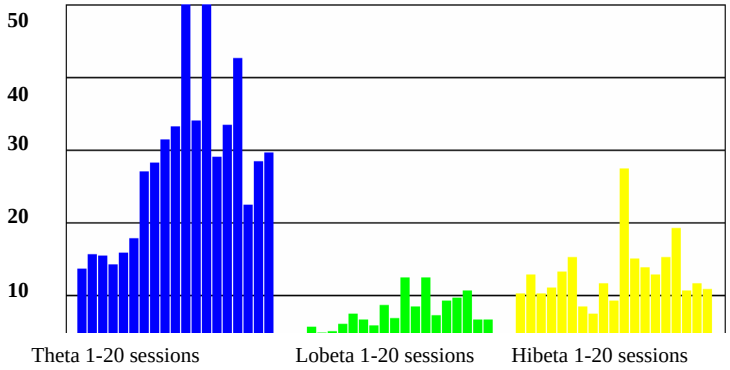
Photo 1: Student involved in a training session. Electrode cap ensures correct placement of electrode lead



Graph 1: 2 Bar-graph summary of sessions for student D.S., according to brainwave type. The neurofeedback clinician interprets mean frequency levels for each individual training session and makes changes to the brainwaves.