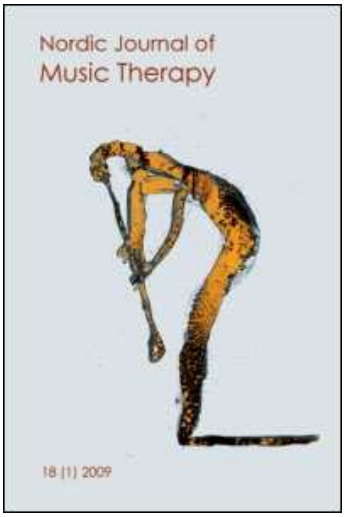

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Music therapy in the treatment of patients with neuro-behavioural disorders stemming from acquired brain injury

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People with neuro-behavioural disorders following brain damage present carers with many challenges, particularly in cases where receptive language may be compromised. Music therapy can reduce behaviours such as anxiety and agitation, and promote positive behaviours in this population. However, empirical and descriptive investigations are lacking. Two single cases illustrate music therapy as part of an interdisciplinary treatment for adults with acquired complex neuro-behavioural disorders. We describe the inclusion of music therapy interventions delivered in graded programmes with two patients with challenging neuro-behavioural disorders. Improved functional abilities included participation and task completion in personal care tasks; acquisition and consistency of spoken language; increased independence; and decreased episodes of challenging behaviour during functional tasks. The findings suggest that music therapy may be effective in decreasing agitation and anxiety, overcoming initiation difficulties, and promoting positive behaviours in populations with neuro-behavioural disorders. Further investigation into the effects of music therapy with adults with neuro-behavioural disorders would assist with providing additional interventions to verbal de-escalation techniques.

Keywords: music therapy; brain injury; neurological rehabilitation; neuro-behavioural disorders

Acquired brain injury and neuro-behavioural disorders

Neuro-behavioural disorders resulting from damage to the frontal and medial temporal lobes or limbic structures are one of the most troubling consequences of acquired traumatic brain injury (TBI). Such disorders have profound and devastating effects for the individual, their family and their carers. Depending on the site of damage, resultant behavioural problems can include verbal and physical aggression, sexual disinhibition and self-injurious behaviour (Rothwell, LaVigna, & Willis, 1999). Frontal lobe

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damage can result in a number of behavioural symptoms such as social disinhibition, impulsivity, egocentric personality, lack of insight, unrealistic attitudes, impaired executive functioning and profound passivity (Pender, 2001). When the medial temporal lobe and limbic structures are involved, behavioural disorders can involve additionally explosive anger and aggression (Ylvisaker, Jacobs, & Feeney, 2003). Some authors have described that ventral frontal injury impairs the ability to learn from consequences and inhibit behaviour based on past consequences, which is a reason to focus on managing settings and antecedents rather than contingency reinforcement in neuro-behavioural settings (Ylvisaker, Turkstra, & Coehlo, 2007).

The complex combination of problems with behaviour, insight and executive functioning challenges healthcare professionals to deliver effective and appropriate therapeutic interventions, both as part of short-term rehabilitation programmes and longer-term management. Thus, individuals with neuro-behavioural disorders are at risk of exclusion from rehabilitation programmes as the safety of other patients and staff around them can be highly compromised (Alderman, Knight, & Henman, 2002). Furthermore, episodes of challenging behaviour can be distressing for relatives and carers to observe, thus risking further isolation. The impact of providing care for such a patient group can lead to high levels of staff stress or burnout (Gerdner, 1999).

Chemical and physical restraints may create additional physical and psychological effects beyond those of the original agitation (Gerdner, 1999), and their use certainly raises moral and ethical issues concerning the treatment of such a vulnerable patient group. Cognitive impairment can reduce an individual's stress threshold due to the decreased ability to receive and process sensory stimuli (Gerdner, 1999). Much of the neuro-behavioural literature has used single case designs limiting the inferences to the wider patient group. In a recent review of the literature, Ylvisaker and colleagues have noted that many of the pre 2000 interventions relied on contingency management, but since 2000 studies have described Positive Behavioural Interventions (Ylvisaker et al., 2003). Such strategies that have proved effective with learning disabled populations have been found similarly useful in the management of neuro-behavioural patient groups (Rothwell et al., 1999; Eames & Wood, 1985). Positive behavioural interventions adopt an applied behaviour analysis approach which focuses upon shifting control of the antecedent triggers in order to manage challenging behaviour instead of focusing on contingency management of the consequent behaviours (Ylvisaker et al., 2003). Behavioural interventions are not subject to the limitations of language-based treatment strategies when working with individuals whose language comprehension cannot be assessed, or who have severe receptive communication disorders or cognitive impairment (Alderman, 2003).

In light of this, investigation is needed into the full range of therapeutic interventions which have been reported in the literature as being successful in managing behavioural disorders. Above all, additional interventions are needed for the nursing staff who manage these patients (Janelli & Kanski, 1997), particularly interventions that are less reliant on intact language comprehension given the complex communication problems common following severe brain injury. Verbal de-escalation techniques such as distraction and redirection are commonly used by all members of the care team as reactive management strategies with this population (Yuen & Benzing, 1996). Additionally, anecdotal report suggests that music based de-escalation techniques can have greater effect than verbal de-escalation techniques in reducing the agitated outbursts in some patients with neuro-behavioural disorders (Soeterik, Roshier, & Quinn, 2005) particularly in cases where severe receptive communication disorders are a compromising factor.

Within the field of brain injury rehabilitation, music therapy has been demonstrated to effect significantly positive changes in functional rehabilitation such as gait retraining (Thaut, McIntosh, Prassas, & Rice, 1993; Hurt, Rice, McIntosh, & Thaut, 1998), improving self-esteem (Purdie, Hamilton, & Baldwin, 1997) and mood states (Magee & Davidson, 2002), and increases participation in neuro-rehabilitation programmes (Nayak, Wheeler, Shiflett, & Agnostinelli, 2000). Music-based de-escalation techniques delivered by a qualified and state-registered Music Therapist are a part of standard clinical care in the neuro-behavioural unit in which the authors used to work (Royal Hospital for Neuro-disability, 2007). However, as evidenced by a literature search conducted on CINAHL, EMBASE, MEDLINE, Allied and Complementary Medicine, Psychinfo, British Nursing Index, AMED, Cochrane Library, and BioMed for the effects of music in reducing agitated behaviour, there are no published descriptive or empirical investigations to date of music therapy or music-based interventions with adults with neuro-behavioural disorders stemming from acquired brain injury. Nevertheless, there are reports of music-based interventions with patients with behaviour disorders in the Alzheimer's disease and learning disabled populations.[1]

Music therapy and music-based interventions to address behavioural disorders

Music therapy and music-based interventions are widely reported as effective in reducing self-injurious behaviour, aggression, agitation and other challenging behaviours of clients with learning disabilities (Savarimuthu & Bunnell, 2002) and with Alzheimer's dementia related disorders (ADRD)

[1]The keywords used in the searches were: music therapy, agitated behaviour, neuro-behavioural and brain injury.

(Brotons & Koger, 1997; Fang-Lou, 2001). Whilst there are mixed reports from small-scale studies measuring the effects of music-based interventions on "negative" behaviours such as agitation, vocalizations, physiological anxiety and aggression (Purdie et al., 1997; Jennings & Vance, 2002), significant improvements in "positive" behaviours during music conditions have been reported such as conversing, smiling and alertness (Purdie et al., 1997) as well as duration of stay in sessions (Mastropieri & Scruggs, 1991). Results of several studies indicate that agitation (Jennings & Vance, 2002; Baker, 2001), anxiety (Hooper & Lindsay, 1990) and feelings of aggression reduce during music conditions (Montello & Coons, 1998). The potential for the planned use of music has also been indicated as an alternative option to using medication and restraints in managing behavioural disorders in people with Alzheimer's disease-related disorders, particularly where music can be used as an environmental factor to decrease behavioural problems (Brotons & Koger, 1997).

In summary, the literature suggests that music is able to reduce negative behaviours and promote positive behaviours related to anxiety and agitation in populations with behaviour disorders. More rigorous research is called for to investigate music-based interventions and their application in inter-disciplinary collaborations (Purdie et al., 1997). Thus, there is support for the argument that research is warranted into the effects of music therapy with neuro-behavioural patients.

Music-based de-escalation in complex neuro-behavioural cases: two case vignettes

A 23-year-old male who suffered a severe brain injury in a road traffic accident was admitted to a specialist neuro-behavioural unit two years post-injury. At the time of injury his Glasgow Coma Scale (Teasdale & Jennett, 1974) was initially 5/15 and he sustained multiple cerebral contusions, a traumatic subarachnoid haemorrhage, left occipital fracture, right parietal fracture and cerebral oedema. Two years before his injury he was becoming increasingly isolated at school and more apathetic. On admission to the rehabilitation unit the patient reported hearing voices (which caused him no concern) and he denied other psychotic symptoms. However, the auditory hallucinations combined with premorbid history of increasing social isolation and apathy suggested that he was experiencing the negative symptoms of schizophrenia.

Referral to a specialist neuro-behavioural unit was necessary, as the patient displayed severe challenging behaviour, which manifested itself in the form of verbal and physical aggression. His challenging behaviour was so severe that his parents, carers, a specialist brain injury nurse and his pet had needed to be hospitalized due to their physical injuries. The community care agency providing his care had withdrawn and he had been excluded

from his local brain injury day centre. Compounding his active behavioural episodes, the patient was also demonstrating passive behaviours through a severe lack of initiation and lack of personal care.

Within 15 minutes of admission to the specialist unit the patient had injured an accompanying relative and two staff, and had destroyed hospital property. He was highly mobile causing a greater level of risk to staff who could not remove themselves to a safe distance when he became aggressive. The patient was presented with attention difficulties, being unable to focus on any task. He was unable to understand verbal instructions, had memory deficits and had severely impaired executive skills. His impaired executive skills were particularly visible during tasks such as eating where it would take him over two hours to eat, as he needed prompting between each mouthful to take another mouthful of food. It was hypothesized that these impairments had both neurological and psychiatric causes.

Setting and antecedents assessed to relate to severe physical and verbal aggression were identified as including: when people attempted to interact with him and his dislike of physical proximity to and physical contact with others. Using positive behaviour intervention strategies to control antecedents that led to aggression and in order to give him a positive experience of interactions, the initial interdisciplinary intervention focused on increasing the patient's tolerance to interaction. Members of staff would remain in his room for periods of five minutes and then hold up a "STOP" sign saying "I'm going to stop now and leave you", before leaving the room. The use of visual aids assisted in compensating his receptive language deficits. As the patient's tolerance of interaction frequency and duration increased, the focus of behaviour management shifted to managing his levels of agitation and aggression during personal activities of daily living (PADL) such as washing and dressing. Due to his dyspraxia and difficulties with sequencing and initiation, he needed both physical and verbal prompts to complete all PADL. Therefore, as part of his behavioural management plan, proactive strategies were put into place to teach the patient functionally related skills consisting of increasing his independence in PADL. It was anticipated that independence would assist with reducing episodes of aggression.

Music therapy (MT) became involved in his rehabilitation programme as song structures had been previously reported to have positive effects on increasing independence in PADL with individuals with executive function disorders following brain injury (Gervin, 1991). Dual diagnosis gave increased complexity to this case and, in the absence of literature to guide the clinician in treating such pathology, intervention followed principles of frontal lobe injury rehabilitation. Assessment aimed to identify the patient's behavioural responses to music, and his ability to follow instructions, initiate and sequence during sung instructions. In addition, assessment aimed to identify whether music conditions increased the duration of the patient's attention to tasks.

Four individual sessions of approximately 20 minutes duration each involved the music therapist and the patient. Sessions involved music-making with the therapist, in which the patient was required to play the drum in response to the therapist's sung instructions. His responses were measured through behavioural observation of targeted behaviours. The assessment findings showed that the patient was able to follow sung instructions. It was observed that structured improvised music-making prompted the patient to initiate playing the drum, demonstrating sequencing skills and the ability to maintain a steady pulse. His response to structured musical procedures in which the therapist sung instructions demonstrated improved levels of social awareness and pragmatic communication skills. For example, during one structured turn-taking exercise, he was able to anticipate when it was his turn to play, imitate rhythmic patterns and appeared to smile whilst participating in the activity. The patient demonstrated sustained attention over a period of 20 minutes of short structured music procedures, with no episodes of agitation or aggression during that time. Music therapy intervention was recommended as part of an integrated programme, as assessment indicated improved levels of initiation, sustained attention, improved interaction skills, and reduced episodes of agitation triggered by demands from staff.

Following team discussions and previous positive reports of music to address these functions, a music therapy compensatory technique (Gervin, 1991) was introduced with the aim of increasing the patient's independence during tooth-brushing. Staff had already attempted to use hand-over-hand facilitation and verbal prompting to encourage the patient to successfully complete the task of tooth-brushing, but these trials had resulted in increased verbal and physical aggression and non-completion of the task. Attempts to engage the patient in tooth-brushing required staff to prepare all the equipment and usually resulted in the patient placing the brush in and taking the brush out of his mouth before stopping the task altogether. Gervin (1991) reported the use of a music therapy compensatory technique to provide auditory cues in the form of song lyrics within a musical framework. Thus, it was hypothesised that "the systematic application of external cues in the form of song lyric with an accompanying tempo for pacing ... addresses disorders in initiation, sequencing, motor planning and problem solving" (Gervin, 1991). If the technique was found to be successful during tooth-brushing, the team planned to progress to more complicated tasks.

In order for the tooth-brushing song to be successful, collaborative work was essential. The occupational therapist (OT) carried out a PADL task analysis, breaking down the task into a sequence of steps required for successful task completion. The speech and language therapist (SLT) carried out a receptive language assessment advising on the optimal language

structure to be used in sung prompts which would be simple enough for the patient to follow.

The tooth-brushing song was composed taking into account the patient's preferred music tastes and his age. A blues style was chosen because it was a familiar structure to the patient, and therefore would have helped to minimize his anxiety levels. Furthermore, the parameters of the music (tempo, rhythm, dynamics) were adapted so that the chances of him becoming over-stimulated and subsequently agitated were minimized. However, it was important that the song was in a style lively enough to motivate the patient, and fun so that he would enjoy participating in the task. Musical and verbal cues were used to prepare him for the task. The melody was created so that it reflected the word meaning. For example, the melody for the phrase "brush the front teeth, forwards and backwards" was reversed for the subsequent phrase "backwards and forwards" (Figure 1). Statements of positive reinforcement were included in the song with the aim of encouraging the patient to keep participating in the task.

Clinical reasoning was used to develop appropriate goals and interventions at all times within the programme; it refers to the process by which the therapist structures goals, intervention processes and management strategies based on clinical data, client choices, professional judgement and knowledge (Higgs & Jones, 2000). Clinical reasoning supported using a song structure with repetitive, syntactically simple lyrics to address a functional ability with this patient. The use of culturally familiar musical syntax provided a framework in which steps within the task could be anticipated and structured. It was anticipated that musical cues would enable the patient to successfully initiate the task of tooth-brushing, sequence the steps involved in the task, and prevent perseveration during the task, allowing for successful completion of the task. Most importantly, musical facilitation required minimal physical intervention which was a known behavioural trigger for this patient. Thus, benefits from using a music-based approach were anticipated from linguistic, cognitive and behavioural perspectives. Table 1 outlines the specific aspects of clinical reasoning which directed this treatment.

It was planned to carry out three phases of treatment – phase one in which the song was played live, phase two in which the song was put onto tape, and phase three in which the intervention was removed and keywords only used to facilitate initiation of task. In phase one, joint SLT and MT sessions were carried out on a daily basis (excluding weekends) for six weeks, totalling 30 clinical contacts. When first used, the song needed adjustment to meet the patient's moment-by-moment needs. For example, additional steps were needed for specific parts of the task such as walking to the sink. This was achieved through adding the line "Ready, steady, walk to the sink". The musical interludes between each step needed to be adjusted according to how long it took the patient to complete each step of the task. Initially, a total number of 20 steps were required for the patient to complete the task

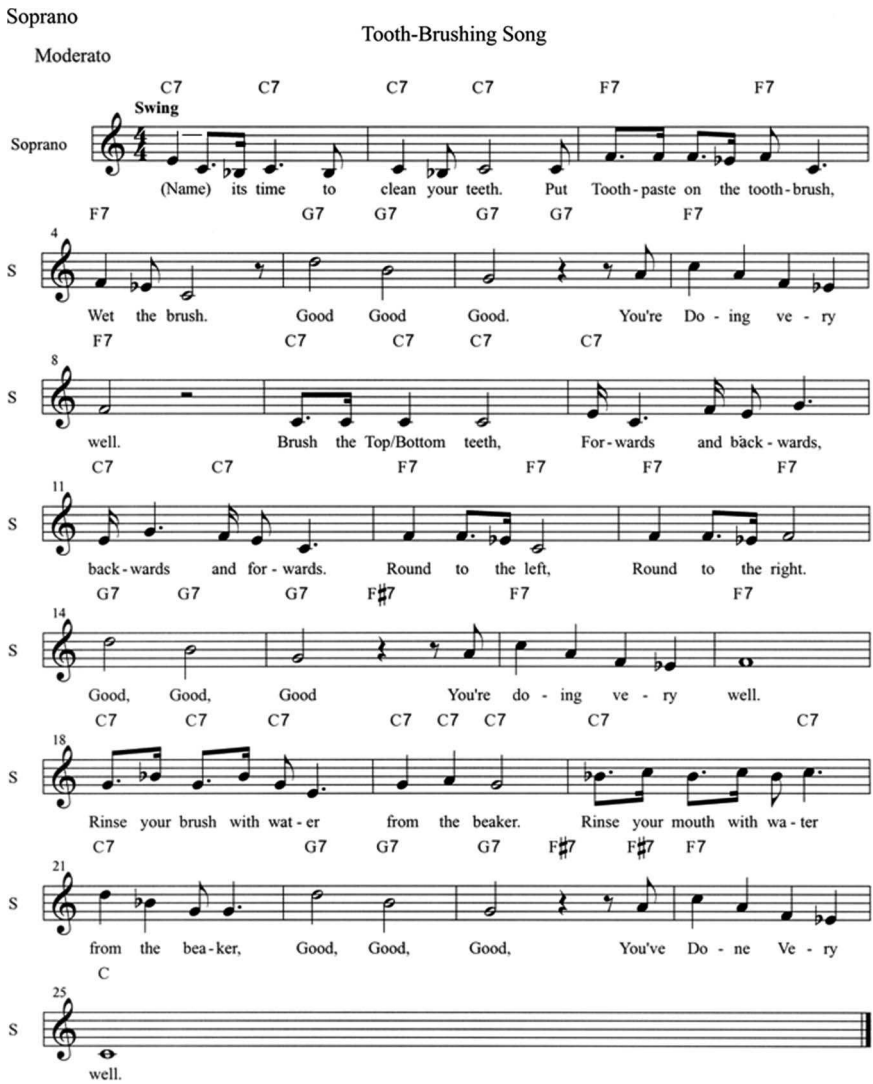

Figure 1. The Toothbrush Song.

successfully. Some steps needed to be repeated during the initial work and the music between each step had to be varied in order to allow for perseverative behaviours.

After six weeks, the patient was successfully achieving the task within five minutes, with no instances of challenging behaviour, although two members of staff were still needed to assist the patient to complete the task successfully: one to set up the equipment and one to play the song. In phase

Table 1. Treatment strategies based in clinical reasoning and predicted clinical outcomes.

Clinical reasoning and treatment strategy	Predicted and observed clinical outcomes
1. The strong structure used repetitive language whilst creating variety through the music	The use of repetitive language in a song structure facilitated familiarity while introducing complexity to assist in task engagement as dependent upon patient response
2. The language used in the song was syntactically simple	Facilitation of language comprehension
3. Patient demonstrated the ability to follow sung instructions in song more consistently than verbal instructions	Higher chance of successful task completion to instructions contained in song
4. The tempo of the live music can be varied by the therapist to assist with pacing the sung instructions at a rate that is individually tailored to the patient's needs	Changing the tempo to match the patient's response rate allowed for his delayed rate of processing
5. The music provided an alternative cueing system through embedded anticipation and expectation of musical structures (e.g. phrase length; harmonic resolution and tension; melodic resolution)	Embedded structures in the music assisted the patient in anticipating sequential events, thus helping him to overcome his receptive language difficulties
6. Repetitive musical structure maximized implicit learning	The repetitive structure facilitated learning the song
7. The use of music involved selective attention to focus on the stimulus and sustain his attention	Improved selective and sustained attention assisted the patient with initiating and sequencing each step of the task
8. The intervention was reliant on auditory stimulus rather than physical intervention	The risk of triggering challenging behaviour in the patient was minimized

two a recording of the song was made in order to increase the patient's independence and reduce the number of staff involved. The recorded version of the song was used twice daily by healthcare assistants when it was time for the patient to clean his teeth. By the second treatment phase the number of steps recorded onto tape had been reduced to 14. In the first week of phase two, one member of staff was needed in the room to observe that he completed the task successfully. By week two, only one member of staff was needed in order to switch on the music. The patient was now successfully completing the task of tooth-brushing within three minutes with no challenging behaviour and reduced numbers of staff required. After four weeks the music was removed with the aim of assessing whether the patient

was still dependent on the song to complete the task successfully. The patient continued to complete the task successfully without the music, and only one member of staff was required to prompt him that it was time to clean his teeth.

As a strategy for teaching independence this technique was very effective, and it was later modified for the task of eating. During meal times, the patient wore a headphone set to prompt him to take mouthfuls of food and chew, to increase his food intake and the speed of eating. As a result of wearing the headset and listening to the tape, the patient's speed of eating increased and he was able to eat his food within 30 minutes. After discharge to another rehabilitation unit, it was reported that he was still able to clean his teeth independently without omitting any steps of the task, and without exhibiting any challenging behaviour.

In a second case, a 25-year-old male was admitted 20 months after a TBI sustained in a road traffic accident. Scans at the time of injury revealed right frontal and left occipital damage and severe intra-cerebral contusions requiring a left occipital craniotomy, evacuation of areas of contused brain in the occipital area, and removal of brain flaps. Later scans showed low attenuation of both frontal regions and posterior left parietal regions and dilation of the left lateral ventricle. On admission to the neuro-behavioural unit it was noted that the patient had right and left optic nerve atrophy, and showed no visual tracking of large objects or light. The patient also demonstrated a lack of eye blink response to threat, but did blink in response to an air current being blown over his cornea. These results are consistent with severe occipital damage and consequently severely impaired sight.

The patient presented both in the general environment and within formal sessions with severe and frequent behavioural outbursts. On admission to the unit, he was assessed as having severe and extreme behaviours using the Agitated Behaviour Scale (Corrigan, 1989), which included physical and verbal aggression directed at objects and staff. Periodically he became elated and euphoric. During structured sessions the patient briefly attended to tasks with appropriate behaviours, however he would become aggressive if demands were placed on him. His profound visual impairment appeared to contribute markedly to his level of anxiety and aggression and the patient relied on auditory feedback from his environment.

The patient had both severe expressive and receptive dysphasia and was consequently unable to express his basic needs. He was able to understand simple one-step sentences, although longer complex sentences resulted in confusion and agitation. He displayed delayed language processing, using perseverative phrases with an unreliable "yes/no" response. Behavioural outbursts prevented the patient engaging in conventional SLT intervention. Despite his considerable communication difficulties, the patient demonstrated a strong residual sense of humour and an extensive love of music. He

spent a significant amount of his day listening to the radio, singing the lyrics to songs which contrasted considerably with his expressive language abilities. Music therapy assessment at 35 months post-injury established the patient could learn and retain language through song, although music triggered agitated behaviours if it was too loud or stimulating, or if competing auditory stimuli were present in the environment, such as voices or television. Music engaged and enabled the patient to build on his residual strengths and it was noted that participation and task completion were improved during music conditions.

Given his positive functional responses to music and more consistent responses during music tasks, intervention aimed to increase the patient's functional language output within structured MT tasks.

Due to the risk of agitation from over-stimulation, recorded music was used in all intervention to ensure a steady level of auditory stimulation. Intervention consisted of three recorded songs. Song A was a familiar song from the current chart music to be sung independently. Song B was a familiar song from the current chart music to be sung with an assistant. Song C was an original song composed and recorded by the music therapist with lyrics composed by the speech and language therapist to match the patient's optimal language abilities observed whilst he was singing. Song C was sung with either the music therapist or the speech and language therapist. The lyrics focused on language used in social interactions such as greetings and saying farewell. Intervention involved singing Songs A, B and C consecutively, was carried out three times weekly for six weeks. Observations recorded which condition optimized the patient's levels of engagement and sustained attention, reduced inappropriate behaviours and maximized language output. A summary of interventions and behavioural responses are provided in Table 2.

The patient demonstrated the greatest level of engagement, appropriate behaviour, task completion and successful language learning during Song C, which was linguistically simple and specifically composed to match his optimal language abilities. The patient showed higher levels of engagement and pleasure in shared singing than when singing alone. Following these positive responses, this method paved the way for future therapy intervention which composed songs with targeted language for the patient to learn, thereby increasing expressive language. By increasing language abilities, we aimed to decrease episodes of the patient's challenging behaviours which were known to occur when the patient had difficulty expressing his needs.

Discussion

The patients were two years' and three years' post injury respectively which meant that spontaneous recovery was less likely (Giles, 2001). The reason

Table 2. Case vignette two: Interventions and responses to music therapy methods to increase language acquisition.

	Inverventions		
Behaviours observed	**Song A** Familiar song sung independenly	**Song B** Familiar song sung with one assistant	**Song C** Song composed to match abilities sung with therapist
Participation and attention to task	Less engagement; sung only part of song.	Sustained engagement throughout task. Heightened mood state.	Sustained engagement throughtout task.
Language learning	Partial: Successful language learning of chorus; inconsistent responses.	Partial: Successful language learning of chorus; tempo and pacing of lyrics too fast; retained melody.	Successful: Successful learning of all the song lyrics.
Behaviours exhibited	Understimulated yawning; turning down volume.	Towards overstimulation: Dancing; moving chair indicating over-stimulation.	Appropriate behaviour and task completion.

for success with the music therapy techniques was first due to specific tailoring to each of the patients' needs. Both patients' engagement in and successful completion of the functional tasks were improved during a music condition rather than during a non-music condition. Several modifications to the previous recommendations for music-based compensatory techniques (Gervin, 1991) were required to meet individual needs. First, the steps required for task completion were very small which enabled a higher success rate. Positive reinforcement for successful completion of each step increases the patient's motivation and mastery. Individualized treatment plans meant that all interventions were targeted to each patient's specific needs. Using live music in the first case enabled greater flexibility in adapting the intervention to the patient's immediate needs. Consistency of intervention is also important for providing patients with an optimal learning environment to facilitate errorless learning and procedural learning. In both cases, recording the song onto a tape enabled consistency of treatment intervention to be maintained between treatment periods and/or different members of the treatment team. Thus, carryover was enabled for nursing staff who, in particular, require additional interventions for managing these patients (Janelli & Kanski, 1997). Collaborative working in both cases ensured that multifaceted parts of the task were matched to the patient's complex needs by drawing on skills and contrasting perspectives of the treatment team, particularly in identifying specific language deficits and strengths and assisting with task analysis. Thus, cognitive abilities impeding performance were identified and musical interventions were planned which reflected the task.

The literature highlights that neuro-behavioural disorders have devastating effects on the patient, their family or informal carers. The lack of information and successful interventions demands the need for further investigation into using innovative individualized techniques such as the music-based techniques reported here. The success of these techniques could provide families and carers with more *tools* for use with people with neuro-behavioural problems, thus helping to reduce levels of injury and stress to staff whilst the patient continues to demonstrate gains in their rehabilitation programme. The outcomes of the complex cases presented here suggest that including music therapy as part of a collaborative treatment programme may have a positive impact on the costs of care through reducing the levels of staff resources required by introducing novel treatment strategies. Furthermore, the reduction of agitation and aggression in such patients helps to increase potential discharge options through the reduced need for specialist behavioural support services. This is particularly important for such patients whose long-term care choices are extremely limited. In the first case example discussed, there was a smooth transition from direct therapeutic intervention to implementation by care staff who used the tape twice daily with only verbal prompts to orientate the patient.

Musical components allow multiple aspects of a patient's functioning to be addressed. For example, tempo can be altered to address delayed responses; formal elements allow for repetition which is the basis of relearning in rehabilitation; pulse aids in initiation and anticipation behaviours which are often impaired in patients with frontal brain damage; melodic direction gives cues for directional movement; and musical style addresses motivational aspects. Overall, using a song structure offers a framework for the patient's behaviour during a task which otherwise results in behavioural outbursts due to the cognitive and emotional challenges of the task. Completing tasks successfully also addresses a patient's self-esteem, particularly when the steps of the task have small graded increments allowing for a higher success rate.

Through using music within antecedent management strategies with neuro-behavioural patient groups, music therapy can offer positive behavioural interventions (Ylvisaker et al., 2003) which in recent years have been found useful in managing this population (Rothwell et al., 1999; Eames & Wood, 2005). Further investigation is warranted into the effects of music therapy with neuro-behavioural patients, particularly as the need for alternative interventions to manage these patients' challenging needs is of utmost priority (Eames & Wood, 1985). Therefore, techniques are needed which can be used in addition to, or as an alternative to, existing models for skills retraining after acquired brain injury. This is particularly important when working with patients whose ability to comprehend language may be compromised by brain damage.

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