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## ORIGINAL ARTICLE

# Effects of video modelling on emerging speech in an adult with traumatic brain injury: Preliminary findings

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## Abstract

**Primary objective:** Research has shown that traumatic brain injury (TBI) can affect a person's ability to perform previously learned skills. Dysexecutive syndrome and inattention, for example, alongside a number of other cognitive and behavioural impairments such as memory loss and lack of motivation, significantly affect day-to-day functioning following TBI. This study examined the efficacy of video modelling in emerging speech in an adult male with TBI caused by an assault.

**Research design:** In an effort to identify functional relations between this novice intervention and the target behaviour, experimental control was achieved by using within-system research methodology, overcoming difficulties of forming groups for such an highly non-homogeneous population.

**Methods and procedures:** Across a number of conditions, the participant watched a videotape in which another adult modelled a selection of 19 spoken words. When this modelled behaviour was performed *in vivo*, then generalization across 76 other words in the absence of a videotape took place.

**Main outcomes and results:** It was revealed that video modelling can promote the performance of previously learned behaviours related to speech, but more significantly it can facilitate the generalization of this verbal behaviour across untrained words.

**Conclusions:** Video modelling could well be added within the rehabilitation programmes for this population.

## Keywords

Speech, traumatic brain injury, video modelling

## History

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## Introduction

Traumatic brain injury (TBI) is considered the leading cause of death and disability in people under 40 years of age worldwide [1, 2], severely disabling 150–200 people per million annually [3, 4]. In the US, the number of people with TBI-related disability has been estimated at ~5.3 million, with 1.4 million new cases each year [5] and, thus, TBI is regarded as one of the most common causes of disability and even death among adults [6]. The prevalence of TBI in Europe is 6.2 million, whilst 200–300 per 100 000 of the population in the UK have a significant disability as a result of head injury [7, 8]. The major causes of TBI are linked with motor vehicle accidents, falls, sports injuries, violent crimes and child abuse across the lifespan [9, 10].

Individuals with TBI present with impairments ranging from mild-to-severe that can affect a variety of domains including cognition, sensory-motor, adaptive behaviours, social skills and communication [11]. Communication

deficits, in particular, result in difficulties in the production and comprehension of spoken and written language [12] and may include aphasia (or dysphasia), apraxia, anomia, dysarthria or deficits in the social use of language (pragmatics) [13, 14]. Further, executive functions, attention and memory are frequently affected [15, 16]. In fact, memory and especially working memory is considered as one of the most impaired of cognitive skills [17–19] and has a direct impact on the well-being, quality-of-life and emotional stability of patients [20, 21] leading to limitation of their independence [22]. In addition to information processing speed, language also requires some degree of working memory and, hence, the latter two are closely inter-related [23]. For example, individuals with TBI perform particularly poorly in language comprehension tasks which typically place high working memory demands [24].

Communication interventions for individuals with TBI can be classified into two main categories; pharmacological and non-pharmacological. Non-pharmacological treatments consist of behavioural or psychological interventions [14], whilst speech-language therapy (SLT) is regarded as the core behavioural approach provided by speech-language pathologists (SLPs) [25]. Although there is currently no consistent

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evidence indicating an advantage of one speech-language intervention over another, the majority of them are based on extensive practice and repetition exercises [26]. There are also a number of different approaches targeting at specific individualized needs of people with TBI such as the metacognitive strategy instruction (MSI) for difficulties related to problem-solving, planning and organization [27], the application of support-oriented intervention that combines behavioural, cognitive and executive function components for dealing with behaviour disorders in people with TBI [28] or the use of a self-coaching approach to social communication after TBI [29] to name a few. SLT, however, may be impeded by behavioural excesses like physical and verbal aggression, difficulty concentrating or attending and other neurobehaviours such as depression, amnesia, anosognosia, comprehension failure or dysfunction in executive functions; planning, abstract thinking, flexibility and behavioural control [30–32]. A common consequence is the presence of non-compliance with the suggestions of the therapist or reduction in motivation that can challenge and prolong the rehabilitation process [33].

Technological advances have dynamically entered in the rehabilitation programmes for people with TBI, mainly as electronic assistive devices for facilitation and increase of their independence (e.g. expert systems, NeuroPage, computer-based activities/programmes, virtual reality) [34–43]. Another significant example should be the application of telecommunications technology—telepractice—to deliver SLT services at a distance, using a real-time audio and visual connection between a client (or group of clients) and a clinician [44]. A few studies have examined the effectiveness of this method of delivering SLT services in individuals with brain injury or speech difficulties with promising results [45–47]. Interestingly enough, a recent study by Schoenberg et al. [48] showed that a computer-based teletherapy cognitive rehabilitation programme for adults with TBI produced not only similar functional outcomes as face-to-face SLT but also at a similar total cost. Nevertheless, video technology as a therapeutic device has rarely been investigated for training patients to perform previously learned skills. In fact, there has been only one study by McGraw-Hunter et al. [49] in which the effectiveness of video technology in a form of self-modelling to teach individuals with TBI cooking skills was examined. In that study, a multi-component treatment package that, apart from self-modelled videos, also included systematic provision of feedback (graduated prompting system, praise and corrective feedback), was shown to be an effective instructional technique for three out of the four participants.

Videos for self-modelling can be accomplished by taping the individual's behaviour over time and editing the tape so that only examples of appropriate target behaviours are on the final tape [50]. This can become a long and even complicated process for some individuals with TBI who may experience difficulties with attention, motivation, remaining on task and, especially, when they present non-compliance or physical and verbal aggression. An alternative would be the use of video modelling in which another person acts as a model [51, 52]. Video modelling has been widely used to teach people with disabilities a variety of skills in a variety of different forms, uses, and contexts, in combination with and without other

behavioural procedures [53–57]. Accordingly, the present study was designed to: (i) provide preliminary data about the effectiveness of video modelling in promoting the performance of previously learned verbal behaviours of a person with TBI, and (ii) examine whether generalization across stimuli and maintenance of any behaviour changes remained after 1- and 2-week follow-up periods.

## Method

### Participant

John (pseudonym), a 34-year-old right-handed man with a multiple diagnosis of brain injury, bacterial encephalitis, abdominal injuries and right hemiplegia caused by an assault, participated in the study. At a functioning level, he presented dyspraxia affecting his ability to perform activities of daily living as well as short-term memory impairments. From the language perspective, he had mainly features of Broca's dysphasia [58]. Thus, John did not have any obvious difficulty in understanding spoken language, as evidenced by his ability to follow instructions and make efforts to communicate, but major difficulties in expressing language (non-fluent speech output) as a result of damage to parts in the lower area of the premotor cortex of his brain. His performance across all spoken language tasks suggested an impairment involving phonological representations. That is, in tasks requiring spoken output, the vast majority of errors were phonologically related to their targets. In more details, verbal comprehension was considerably less impaired than production, as indicated by his tendency to read or even to follow written instructions. John manifested very marked difficulties in the repetition of words, non-words and sentences. His repetition impairment was further influenced by word frequency and also by word length. Reading performance was relatively preserved compared to repetition; however, some elements of surface dyslexia were observed. At the time of the study, he had been receiving a standard rehabilitation programme as an inpatient for ~4 months. Individual SLT was provided to address communication deficits related to dysphasia and to maximize functional abilities to increase independence and participation in the home and community activities. However, he rarely attended his therapeutic sessions during the last month, showing severe signs of loss of motivation and high rates of non-compliance with all therapists.

### Setting

This study was conducted in a rehabilitation centre in the participant's bedroom. A 17-inch television and a chair placed ~2 metres away from it were mainly used.

### Stimulus materials

#### *Videotape*

An unfamiliar adult was used as the model for the construction of a videotape, ~2 minutes long. In the video, the model was shown saying the training words (i.e. 'days' and 'months') at a normal pace. The video presentation avoided any exaggeration in the lip movements of the model; however, only the face of the model was shown.

## Papers

All words, those used for training and for generalization, were printed on papers (size: 297 × 210 mm), using large fonts (i.e. 48pt). The training words were selected in agreement with the participant and comprised of the 7 days of the week and the 12 months of the year. Fifty-seven other words which started with the same syllable as the training ones (i.e. three different words for each day/month) were used as the generalization words. For example, the three words corresponding to 'Monday' were 'Monkey', 'Money' and 'Monk', to 'Thursday' were 'Thirty', 'Theft' and 'Thirsty', to 'March' were 'Mark', 'Marvel' and 'Mars', etc.

## Response measurement and inter-observer agreement

A correct response was defined as emission of the target vocalization within 5 seconds following the respective verbal stimulus and, on some occasions, prompt (i.e. a written word) [59]. Paper-and-pencil data were recorded for each trial by the experimenter and a second observer. These observers scored the participant's verbal responses on a data sheet indicating whether he emitted the correct response or not; hence, event recording was used. The second observer independently collected data during 38% of sessions to provide inter-observer agreement. Agreement was calculated for each session by dividing the number of agreements by the total number of agreements and disagreements and then multiplying by 100%. Mean agreement was 100% for all responses.

## Experimental design

The effects of video modelling on response acquisition were assessed using an AB design, replicated 18 times [60].

## Procedure

In any of the following conditions, each session consisted of a set of five trials with the exception of the generalization probe sessions which each consisted of three trials. In each trial the participant was given up to 5 seconds to repeat the word just heard in the absence of any further instruction or assistance.

### Baseline

During the baseline, the participant was requested to repeat each word that the experimenter had previously said in a clear voice and at a normal pace. Each word was also presented simultaneously on the paper, written in large fonts.

### Video modelling

In the video modelling condition, the participant watched a videotape showing only the face of an unfamiliar model saying each training word in a clear voice, but at a normal pace. Then, the respective word appeared on the screen for 2 seconds in a similar font size as it was presented on the paper. No particular instructions (e.g. 'watch' carefully the mouth or 'look' at the mouth of the model) or consequences were given to the participant during any condition. However, the participant was occasionally provided with a simplified graph similar to Figures 2–4 below showing his progress during a preceding session.

## Generalization

When the participant reached the criterion of repeating each respective word four out of five times correctly (80%), he was assessed in the absence of any video, as it occurred in baseline, during one session (5 trials). Following an absolute successful performance (5 out of 5 correctly), generalization probes (3 trials) using the word which would subsequently be shown in the video took place. These probes assessed whether a video presentation was necessary for the participant to repeat the modelled word. When all training words were performed successfully *in vivo*, then generalization across the 57 other words was assessed. Only one session (5 trials) was conducted for each of these words in an identical way as at baseline.

Overall, intervention (video modelling and generalization probes/sessions) was implemented for 14 non-consecutive days and for ~10–15 minutes each day.

## Follow-up

Follow-up measures were obtained 1 and 2 weeks after the final measurements for the training words had been taken. The setting and the procedures during follow-up sessions were identical to those used during all the baseline sessions.

## Results

Table I presents the overall mean percentages of the correct responses for John across the training and generalization words. During the baseline, John demonstrated an average of  $17.9\% \pm 14.9\%$  (range = 0–60%) correct responses for the training words and  $15.7\% \pm 15.4\%$  (range = 0–60%) for the generalization words, respectively. Then, during the intervention, video modelling was introduced for the training words only and the mean percentage of correct responses showed an increase of 41.6% (range = 0–100%). An increase of 39.2% (range = 0–100%) was shown for the generalization words, for which video modelling was not used. Even better results were obtained at follow-up, where mean percentages of correct responses for both the training and generalization words were importantly higher than those obtained during baseline.

Examples of detailed data collected during video modelling procedures can be seen in Figures 1 and 2 for 2 training days (i.e. Tuesday and Saturday) and in Figures 3 and 4 for 2 training months (i.e. January and September). Thus, during baseline, John did not meet the criterion of repeating the word 'Tuesday' four out of five times correctly (i.e. 80%) in any of the three sessions. When video modelling was introduced, his performance improved, reaching the criterion within two sessions (10 trials). However, in the next set of five trials (one session), wherein video modelling was withdrawn, his performance deteriorated and, therefore, video modelling was introduced again. Criterion was met within the minimum of one session but, again, this criterion failed to remain at the

Table I. Mean percentages of correct responses.

	Baseline	Intervention	Follow-up
Training words	$17.9 \pm 14.9$	$59.5 \pm 22.3$	$77.4 \pm 13.9$
Generalization words	$15.7 \pm 15.4$	$54.9 \pm 19.4$	$72.1 \pm 14.5$

Values are mean  $\pm$  SD.

Figure 1. Percentages of correct responses for the training word ‘Tuesday’ during all conditions. GP indicates the generalization probe sessions.

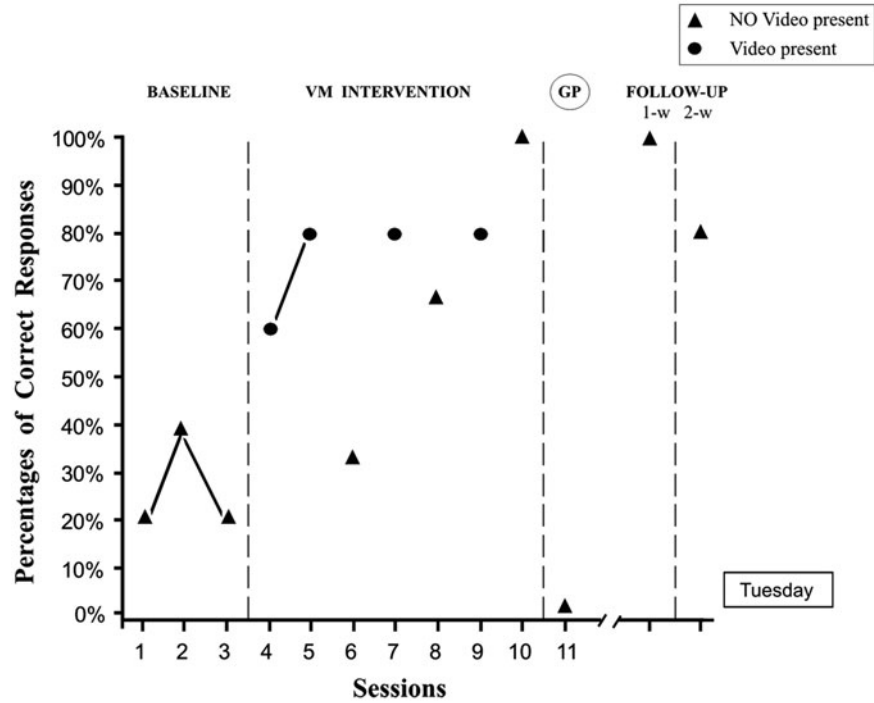
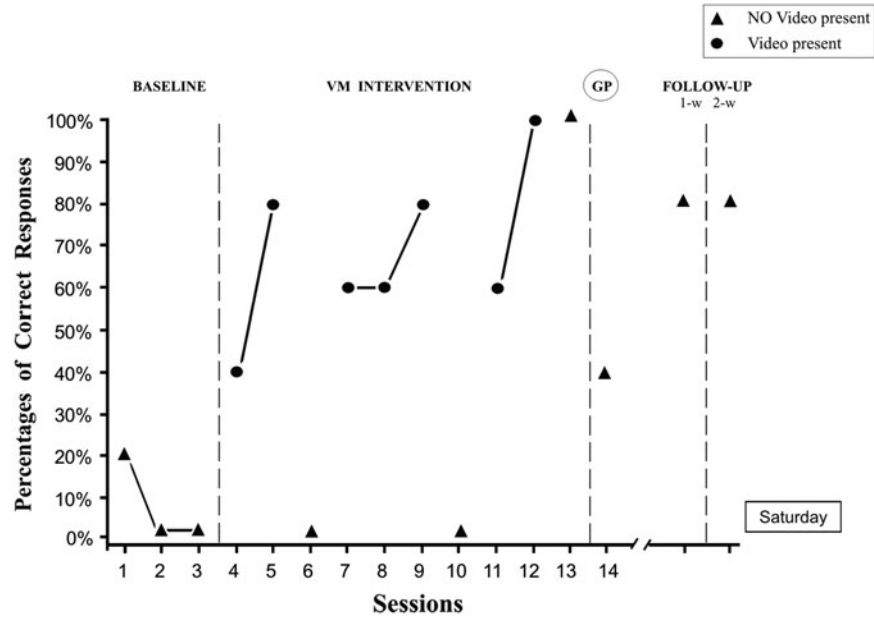


Figure 2. Percentages of correct responses for the training word ‘Saturday’ during all conditions. GP indicates the generalization probe sessions.



required level during the subsequent session when video modelling had been removed. Video modelling was re-introduced and once again the criterion was reached within one session. When video presentation was removed again, successful performance remained at the highest level of 100%; however, this responding did not generalize to a different training word (session 11), indicating that video modelling would have to be used for that respective word as well. Successful responding for the training word ‘Tuesday’ was maintained at 1- and 2-weeks follow-up. Similar results were also obtained for the training of the word ‘Saturday’ (Figure 2), where video modelling was also introduced 3-times before successful performance in the absence of it

occurred at session 13. John’s performance was similar for the training months during intervention and at follow-up (Figures 3 and 4); however, successful responding was achieved within fewer sessions.

### Discussion

Previous research using individuals with TBI has shown that video technology, as part of a multi-component treatment package, can be an effective teaching tool [49]. The results of the current study showed that video modelling can promote the performance of previously learned verbal behaviours in an adult with TBI, whose spontaneous speech was non-fluent



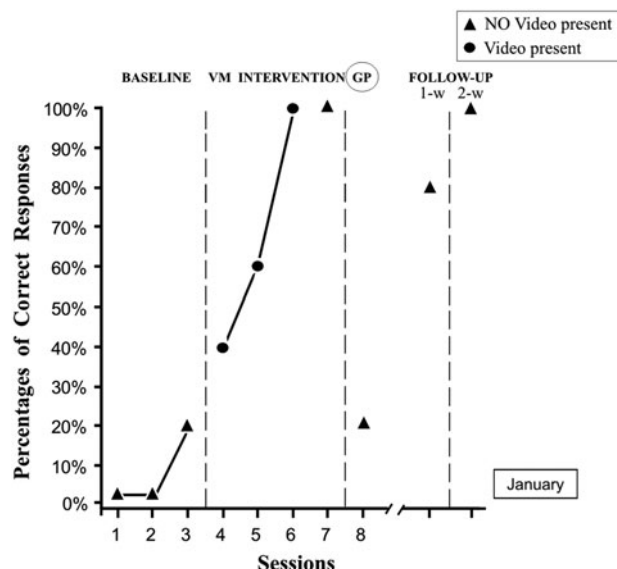


Figure 3. Percentages of correct responses for the training word 'January' during all conditions. GP indicates the generalization probe sessions.

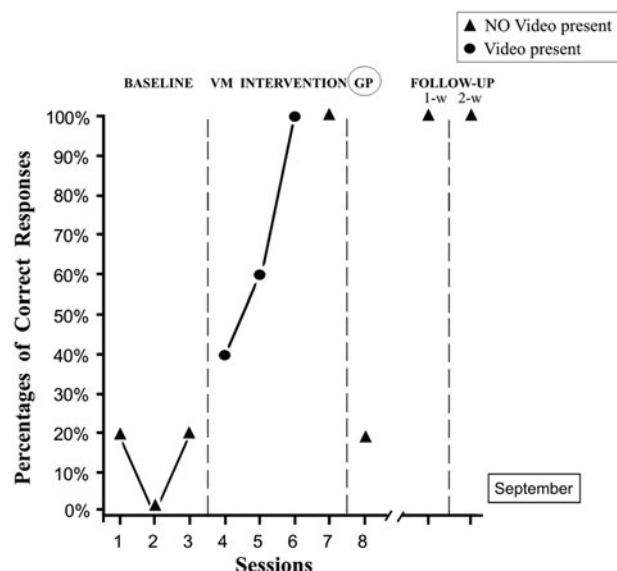


Figure 4. Percentages of correct responses for the training word 'September' during all conditions. GP indicates the generalization probe sessions.

and sparse in nature with significant word finding difficulties, greatly reduced phrase length and a paucity of spontaneous utterances. Most importantly, this brief intervention facilitated the generalization across a number of untrained words. That is, the participant became able to say a new word which started with the same syllable with the ones that he had been taught during the video modelling with less effort and in the absence of any specific training. These results were maintained at 1- and 2-week follow-ups.

This success could be attributed to a number of possible factors. First, the use of videos as therapeutic means can bring the relevant situational cues closer together within a visual frame (e.g. settings, models, stimuli, etc.), helping individuals with cognitive impairments to follow the respective cues. Second, it has been well reported in the literature that visual

input processing is vastly superior to auditory processing in cases with evident cognitive impairments [51]. Reduction in motivation has also been associated with TBI. Since patient involvement has a positive influence on patient outcomes, this is an important aspect that can affect different types of rehabilitation programmes [61–63]. The participant in the current study was not an exception; he rarely attended his therapeutic sessions for a significant period of time. However, his motivation levels seemed to be enhanced, as evidenced by his participation in the video modelling intervention, possibly because he obtained instant access to his progress rate through the use of the simplified graphs. Finally, literature has suggested that video modelling may generally be an effective teaching strategy for rapidly acquiring high levels of generalization and maintenance, at least for individuals with intellectual and developmental disabilities [64–66].

Inevitably, although essential if one is to ensure that high quality evidence-based practice is delivered to the patients, conducting research within a real world setting with multiple changing variables presents challenges to the researcher and this study was not without its limitations that inform routes for further research. For example, whilst lowered motivation following brain injury is an important determinant for the outcomes of the rehabilitation progress, currently, there is not any available tool which reliably assesses motivation levels among individuals with TBI [33]. Hence, it remains rather unclear whether video modelling without the provision of intermittent feedback (i.e. graphs) would have been sufficient for producing the desirable behaviour changes.

Although single-case research designs have been suggested as a powerful set of tools for the clinicians to evaluate their practice and make data-driven decisions [67–69], questions regarding sample size are often raised in relation to these methods. The search for functional relations between dependent and independent variables is advanced if experimental control over behaviour can be demonstrated. This was demonstrated for this participant and his individual differences were not masked by group averages. Moreover, there are particular difficulties in applying group methodologies to the study of behaviour change of individuals with TBI, since they comprise a highly non-homogeneous population and, hence, a highly individualized approach to treatment is essential [70]. Similarly, it could be argued that the selection of the participant and in the absence of any formal linguistic and cognitive measurements prior to the study, invoked some sort of bias for the success of this study. However, the comparisons of baseline performances with experimental conditions counter this suggestion [71]. Furthermore, these methods can offer immediate feedback to the treatment provider regarding treatment effectiveness based on direct and repeated measurements of the target behaviour, which can be shared with the service user as it occurred in the present study. Of course, replication with additional individuals needs to be addressed in future studies.

Future research would also examine alternative ways of designing video modelling procedures, particularly for patients who present difficulties to repeat lengthy words and sentences (longer words may be more difficult) and paraphasias in their language. Initially, video modelling could be structured to teach the person short words with a meaning and gradually

increasing their length. Such words might include verbs like put, keep, eat, want or nouns like pot, bet, tap, cup, day, etc. After the person has become able to produce such words, at a next stage, longer words or phrases such as pottery (pot), cup of coffee (cup), keep the money (keep), eat food (eat), tap water (tap), I want food (want), etc., may be used. Further, the effectiveness of video modelling would be assessed in a variety of areas such as self-care, social, vocational and even more complex communication skills. It could also be argued that, although video modelling may be appropriate in some settings, it might not be practical in community settings such as supported employment. The use of mobile computing devices (e.g. iPod, iPad, etc.) would facilitate the broad use of video modelling and preliminary evidence with students with autism has been encouraging [72]. Certainly, more research towards that direction is needed.

In recent years and due to advances in acute care, survival rates following severe brain injury have improved dramatically [31]. Hence, the requirements for rehabilitation of patients after TBI who present with deficits in communication including speech and language have increased dramatically [73]. Video modelling could well be added within the rehabilitation programmes for this population. The positive effects of this intervention are usually immediate and dramatic and, therefore, less treatment time is required. It has also a unique advantage over other types of interventions in that it does not require extensive staff training prior to implementation, making it particularly cost effective.

### Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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