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The production effect in adults with dysarthria: improving long-term verbal memory by vocal production

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**ABSTRACT**

People show better memory for words read aloud relative to words read silently, the Production Effect (PE). Vocalisation at study makes the produced (aloud) words more distinct than the non-produced (silent) words, hence more memorable. Such encoding distinctiveness is related to the additional processing of aloud words that is later used during retrieval. This study investigated the PE in dysarthric adults, characterised by speech production difficulties. Their memory performance (recognition) was compared to a group of healthy adults. Results showed a PE for both groups. The production benefit was significantly larger for the dysarthric adults, despite their overall memory performance being reduced relative to controls. The results demonstrate long-term verbal memory deficits in dysarthria, and suggest that vocalisation (although impaired) may assist in remembering. Hence, vocalisation may be used in intervention contexts with this population, to compensate for memory decrease.

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**KEYWORDS** Dysarthria; long-term memory; production effect; word recognition; encoding distinctiveness

**Introduction**

The production effect in memory

Reading aloud enhances memory for words relative to silent reading. This simple yet robust encoding technique is known as the Production Effect (PE; MacLeod, Gopie, Hourihan, Neary, & Ozubko, 2010). In recent years, the PE has been the focus of numerous studies, which have demonstrated its reliable benefit both for recognition tests (Forrin, MacLeod, & Ozubko, 2012; MacLeod, 2011; Ozubko, Hourihan, & MacLeod, 2012) and free recall (Icht, Mama, & Algom, 2014; Lin & MacLeod, 2012; Mama & Icht, 2016b). The PE extends to other types of productions, such as mouthing, writing, and typing. All of which involve the execution of a distinct, item-specific response, and were found to improve memory relative to silent reading. Yet, reading aloud was found to yield the greatest improvement (Forrin et al., 2012).

The PE has been shown to appear across a variety of stimulus types, including non-words (MacLeod et al., 2010, Experiment 6), pictures (Fawcett, Quinlan, & Taylor, 2012),...
and text (Ozubko et al., 2012). It is evident across the lifespan, in pre-school children (Icht & Mama, 2015) as well as older adults (Lin & MacLeod, 2012), mainly using within-subject experimental designs, in which aloud and silent words are intermixed in a single study list.

The prevalent explanation of the PE is Encoding Distinctiveness (MacLeod et al., 2010). Accordingly, vocalisation creates a distinct processing dimension that causes aloud words to stand out relative to the remaining silent words. Since the aloud words are relatively more distinct and unique, at test they are better remembered than the silent words (Forrin, Jonker, & MacLeod, 2014). One can interpret encoding distinctiveness in light of the number of distinct encoding processes that occur at study—the greater their number, the larger the memory enhancement (Forrin et al., 2012; Mama & Icht, 2016a). Silent reading involves a single encoding process (visual), while reading aloud also includes articulation (sensory-motor encoding process) and hearing (auditory encoding process). Therefore, the number of unique encoding processes involved in learning determines the magnitude of the PE.

Suppose that one of the encoding processes in learning is absent or impaired. Encoding distinctiveness predicts memory decrease in such case. A support for this assumption was obtained using production by mouthing (voicelessly articulating). Mouthing removes the auditory processing of the study words. Hence, it involves only two encoding processes—visual (reading) and motor (articulation). Mouthing was found to improve memory relative to silent reading (a single visual encoding process), but to a lesser extent than reading aloud (three processes—visual, motor and auditory; Forrin et al., 2012, Exp. 2B). A similar pattern of results was documented with production by whispering (Forrin et al., 2012, Exp. 2C). Whispered words were more memorable than silently read words, because whispering involves two additional, distinct processes (articulation and audition) relative to reading silently. However, words that were read aloud were remembered better than whispered words, probably because in whispering, the acoustic signal is weaker than the signal when reading aloud (resulting in a weaker record of processing, Forrin et al., 2012, p. 1053).

While a weaker encoding processing (e.g., whispering or mouthing, relative to reading aloud) results in a moderate memory improvement, enhanced or excessive processing may lead to larger memory benefits. For example, Quinlan and Taylor (2013) showed that unique (and somewhat bizarre or unusual) responses such as reading items aloud loudly (Experiment 1) and singing items aloud (Experiment 2) produced a larger PE than reading items aloud in a normal voice. A possible explanation for the production benefit of unusual productions (e.g., singing) may be related to their high levels of difficulty and effort. The desirable difficulties account (Bjork, 1994, 1999) suggests that effortful encoding methods, which create difficulties at study, enhance long-term memory (retention). According to this account, as learning is more effortful and demanding, it activates encoding and retrieval processes that improve later remembering (Bjork & Bjork, 2011).

Following these findings, this study focused on a special population, a group of adults with acquired dysarthria, a pathology characterised by distorted speech production. Long-term memory for silent and aloud words was tested, in order to evaluate the production benefit. Silent reading should not be affected by the motor speech impairment; hence, we expect similar recognition of silent words for dysarthric participants and healthy controls. However, we debated regarding aloud words’ recall. On the one hand, the vocal production of dysarthric individuals is impaired, hence the
articulatory encoding process is weak, and both the tactile and the auditory encoding processes are decreased. Since aloud responses are distorted (due to the slurred speech production) and softer in loudness (resulting in spectral flatness), we assume they will be less item-specific, perhaps similar to whispered responses for healthy individuals (Forrin et al., 2012; MacLeod et al., 2010). Because memory for aloud words will be lessened while memory for silent words will not be affected, we expect the PE size to be reduced for dysarthric participants relative to controls.

On the other hand, for dysarthric patients, vocal production may be more demanding and effortful than it is for healthy individuals. In fact, the difficulty of vocalisation may be desirable, resulting in larger memory benefits. In this case, memory for aloud words will be better for dysarthric adult than for healthy controls (while memory for silent words will be similar), and their PE would be larger. Next, we will describe the main characteristics of dysarthria.

**Dysarthria**

Dysarthria is a neurologic speech disorder that reflects abnormalities in the strength, speed, range, steadiness, tone or accuracy of movements required for breathing, phonatory, resonatory, articulatory or prosodic aspects of speech production (Duffy, 2013). It is associated with neurologic disorders such as stroke, Down syndrome, cerebral palsy, Guillain-Barré syndrome, traumatic brain injury, or Parkinson's disease. These disruptions do not affect the language comprehension or cognitive aspects of natural language production (Mahler & Ramig, 2012). Consequently, speech is negatively affected, and is considered atypical, relatively unintelligible and “slurred” (Kent, 2000).

Dysarthria is categorised into different types by distinguishable perceptual characteristics and, presumably, a different underlying neuro-pathophysiology. The most popular classification system is the Mayo System (Darley, Aronson, & Brown, 1969a, 1969b). However, there is much in common to speakers with dysarthria, regardless of its type (Kim, Kent, & Weismer, 2011).

By definition, dysarthria is a motor disorder, characterised particularly by reduced speech intelligibility. However, this speech impairment rarely occurs in isolation, and cognitive deficits often accompany dysarthria (Duffy, 2013). Attention and memory impairments are common after an ischemic stroke (Langhorne, Bernhardt, & Kwakkel, 2011). Yet, the literature regarding memory abilities of individuals with dysarthria is scarce, and shows inconsistent results. For example, Baddeley and Wilson (1985) concluded that dysarthric patients have intact working memory abilities, since their subvocal rehearsal abilities are not affected by their loss of articulation abilities. However, Ravizza et al. (2006) found verbal working memory deficits in patients with dysarthria associated with cerebellar damage. Hitherto, long-term memory abilities of individuals with dysarthria have not been tested. This study aimed to shed light on these abilities, using a PE procedure.

**The present study**

In this study, we compared the PE in two groups of older adults—with dysarthria (as their isolated or major symptom, study group) and healthy (control group). All participants were visually presented with a list of familiar words at the time of study, and were required to say aloud half of them (vocal production) and to read silently the
remaining half. Following study, a recognition test was performed. According to encoding distinctiveness, we predicted a PE for both groups (advantage of aloud over silent words), but smaller for the study group relative to the control group. Specifically, we assumed that fewer aloud words would be recognised by the dysarthric patients, due to their distorted speech, which impairs the encoding process of the aloud words. We expected that silent word recognition would be similar for the two groups (Baddeley & Wilson, 1985). The results have theoretical importance, better understanding the mechanism underlying the PE, as well as clinical implications, considering the PE as a mnemonic in dysarthria.

Method

Participants

Study group: Fourteen dysarthric subjects were recruited for participation in this study by a speech-language pathologist at the Bayit Balev Geriatric Medical center (Bat Yam, Israel). Two of them failed to complete the experimental task, and their data was excluded. The final sample included twelve dysarthric subjects (eight males, four females), between the ages of 57 and 81 years old (average age: 67.4 years, sd = 6.7), all had dysarthria (flaccid, spastic, or ataxic) resulting from first CVA (cerebrovascular accident, stroke). Eleven participants did not show cognitive impairments, as quantified by the Hebrew version of the MMSE (Mini-mental state examination; Werner, Heinik, Mendel, Reicher, & Bleich, 1999), >26. A single participant (#12) showed a mild cognitive impairment (MMSE = 22).

A speech-language pathologist (second author) assessed the motor functions of each participant according to the standardised Frenchay Dysarthria Assessment (FDA; Enderby, 1983). This tool measures 28 relevant perceptual dimensions of speech, and quantifies the intelligibility of single words and sentences of adults with dysarthria. It provides data regarding the speaking rates, and includes analysis of the movement of the articulators in non-linguistic contexts. Table 1 summarises the dysarthric participants’ data.

Control group: The dysarthric individuals were matched according to age with fourteen non-dysarthric subjects from the general population (between the ages of 58 and 85 years old, average age: 66.8 years, sd = 6.8). Controls’ gender was not fully matched (six males, eight females. Note, however, that gender is a negligible variable in the PE

Table 1. Description of participants with dysarthria (dysarthria types adapted from: Duffy, 2013; Kirshner, 2002).

<table>
<thead>
<tr>
<th>Dysarthria type (Locus; Primary Deficit)</th>
<th>No.</th>
<th>Age (years)</th>
<th>Gender (M, F)</th>
<th>Cognitive function (MMSE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spastic (Bilateral / unilateral upper motor neuron; Spasticity, strain-strangle)</td>
<td>1</td>
<td>70</td>
<td>M</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>72</td>
<td>M</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>81</td>
<td>M</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>68</td>
<td>M</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>57</td>
<td>M</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>61</td>
<td>F</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>65</td>
<td>M</td>
<td>27</td>
</tr>
<tr>
<td>Ataxic (Cerebellum; Incoordination)</td>
<td>8</td>
<td>66</td>
<td>F</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>69</td>
<td>M</td>
<td>28</td>
</tr>
<tr>
<td>Flaccid (Lower motor neuron; Weakness, breathiness)</td>
<td>10</td>
<td>65</td>
<td>F</td>
<td>28</td>
</tr>
<tr>
<td>Hypokinetic (Basal ganglia control circuit; Rigidity)</td>
<td>11</td>
<td>60</td>
<td>F</td>
<td>30</td>
</tr>
<tr>
<td>Mixed (Upper and lower motor neuron; More than one)</td>
<td>12</td>
<td>75</td>
<td>M</td>
<td>22</td>
</tr>
</tbody>
</table>
literature). These participants were recruited from two different independent-living retirement homes, and two community centres, all located in the centre of Israel. All participants showed normal cognitive abilities (MMSE > 26). Control participants were excluded if they reported (in an interview conducted by a research assistant, speech-language pathology student) one or more of the following diagnoses: (a) neurological disorders that may affect the speech mechanisms; (b) structural or functional abnormalities of the oral mechanism; (c) respiratory diseases (e.g., bronchial asthma, respiratory infection).

All participants (dysarthric and controls) were required to have a negative history of severe hearing or visual problems. Each subject began the data collection process with a short questionnaire that included general demographic data and health-related questions that can affect speech functions including various types of motor problems, both gross (e.g., standing, balancing) and fine (e.g., writing, swallowing). The study was approved by the ethics committee of Maccabi Health care services group.

**Apparatus and stimuli**

A pool of 80 common Hebrew words was used, all bi-syllabic nouns, three to five letters long (these words were used in previous PE experiments, see: Icht et al., 2014). From this pool, a random sample of 40 words was selected for study for each participant, under the control of DirectRT programme. The remaining 40 words were used as distracters in the final recognition test.

The words were visually presented in black against a white background, in 36-point David font. Each of the 40 words appeared at the centre of a 15-inch colour monitor (Lenovo laptop computer). On each trial, a small icon (sized 2 cm²) appeared approximately 5 cm above the study word. The icon was a small picture of a microphone or lips (a closed mouth), indicating the appropriate mode of production for that word: vocal production (random 20 words), or silent reading (the remaining 20 words).

**Design and procedure**

The participants were tested individually in a quiet room in the rehabilitation centre (study group) or in the community centre they attended (control group). A research assistant was present in the room throughout the experimental session, seated next to the participant. Upon arrival, the participants read and signed an informed consent form, and answered a short questionnaire (personal data). Following this, they were given a short explanation regarding the study. The participants were told that the goal was to learn each word via the mode signalled by the icon (microphone, lips) and that a memory test would follow the presentation of the entire list of words. Then, the participant was seated at a distance of 50 cm from the centre of the screen. Following a short practice phase of four words (two words for each of the two conditions) the study phase was begun.

The study phase was similar for all participants, as all were visually presented with a random sample of 40 study words (20 were read aloud and 20 were read silently, intermixed). On each trial, the icon was presented for 0.5 s. Following this, the appropriate visual word was presented for 3 s. A blank screen of 1 s followed (the interval between words was about 4 s).
After the presentation of the study list, the participants performed a short (filler) task. They were given 4 min. to complete five simple arithmetic problems (multiplication of two-digit numbers). The problems were printed on an A4 paper.

A written recognition test followed. Participants were given a paper listed with the 40 words from study, and an additional 40 new words (word order was different for each participant). They were asked to mark the study words, regardless of their learning condition (aloud or silent reading). There was no time limit for this test. This testing procedure was chosen since it provides more contextual support relative to recall tests (Whitbourne & Whitbourne, 2010). Moreover, this particular recognition test, which presents the entire list of words at once, requires less time and effort to accomplish relative to other recognition procedures, which involve consecutive presentation of individual items. Since our participants were neurologically impaired, adapting the memory test to their abilities and special needs was especially important (Ayers et al., 2007; Ben-David & Icht, 2016. For a similar recognition test, see: Janowsky, Shimamura, Kritchevsky, & Squire, 1989; Tulving, Schacter, & Stark, 1982). The whole experimental session lasted approximately 30 min.

**Data analysis**

False alarms: Data analysis revealed that false alarms were relatively low (dysarthric: \( M = .05 \), controls: \( M = .04 \)) and did not differ reliably between the groups, \( t(24) = .66, p > .51 \). This result will not be further discussed.

**Gender effect:** As gender was not fully matched across the dysarthric and control groups, we verified that it did not affect memory performance. We used a repeated measures ANOVA with group (dysarthric, control) and gender (males, females) as between participants variables, and learning condition (aloud or silent reading) as a within participants variable. This analysis revealed no main effect for gender and no interactions with gender (\( F_s < 1 \)). Thus, in the following analysis we averaged data across gender groups.

**Results**

The recognition data are shown in Figure 1. Plotted are the mean proportions of “yes” responses (hits) in each learning condition (aloud or silent reading), as well as the false alarm rates (new, unstudied words that were mistakenly marked at the recognition test). Visual inspection of Figure 1 reveals the advantage for aloud words over silent words (a PE), for both study and control groups. Although the pattern of results seems similar for both groups, it appears that the PE size is larger for the study group.

Statistical analysis supports these observations. A repeated measures ANOVA with learning condition (aloud or silent reading) as a within-subject factor and group (dysarthric, healthy) as a between-subject factor, revealed a main effect for learning condition, with better memory for aloud than for silent words, \( F(1,24) = 57.91, p < .001, \eta^2 = .71 \). However, a significant interaction of this pair of variables was found, \( F(1,24) = 4.20, p = .05, \eta^2 = .15 \). This interaction demonstrates that the size of the PE was different for the two groups, larger for the dysarthric (\( M_{aloud} = .53, M_{silent} = .25 \)), \( t(11) = 5.61, p < .001 \), relative to the controls (\( M_{aloud} = .65, M_{silent} = .49 \)), \( t(13) = 4.96, p < .001 \).

A main effect for group was also found, with higher recognition rates for the controls relative to the study group, \( F(1,24) = 9.16, p < .01, \eta^2 = .28 \). This effect resulted from a
difference in the number of correctly recognised aloud words, \( t(24) = 2.08, p < .05 \), along with a difference in the number of correctly recognised silent words, \( t(24) = 3.27, p < .005 \).

**Discussion**

About a third of stroke survivors experience lifetime disabilities (Bowen et al., 2012). Among these patients, persisting speech difficulties (e.g., dysarthria) are prevalent (Enderby & Davies, 1989). This functional communication difficulty has detrimental effects on independence and social participation (Brumfit, 1998; Hilari et al., 2010; Thomas & Lincoln, 2006). Hence, it is important to develop and evaluate appropriate rehabilitation methods and clinical practice approaches (Royal College of Speech and Language Therapists, 2009; Scottish Intercollegiate Guidelines Network [SIGN], 2002). This is especially true regarding treatments for dysarthria (SIGN, 2002; Sellars, Hughes, & Langhorne, 2005), that have been somewhat neglected in previous research (Bowen et al., 2012).

Intervention techniques for people with dysarthria include traditional speech therapies (Young, Gomersall, Bowen, & ACT NoW Investigators, 2013), such as intervention which focuses on specific components of the speech production process (Yorkston et al., 2001). Intervention studies have reported improvements in muscle strength and control, reduction in consonant imprecision, and improved speech intelligibility. Reviewing the relevant literature, there is a consensus that speech therapy following stroke is beneficial (Marsh, Bertranou, Suominen, & Venkatachalam, 2010; RCSLT, 2009; SIGN, 2002). However, the clinical effectiveness of cognitive rehabilitation for memory deficits of individuals following stroke is not clear (das Nair & Lincoln, 2007).
This study focused on long-term verbal memory abilities of dysarthric adults, and evaluated the PE in a group of patients and of healthy age-matched controls. The results demonstrated production benefit in both groups, larger for the dysarthric relative to the controls. Moreover, the dysarthric adults showed reduced overall memory performance, e.g., recognised fewer study words (aloud as well as silent) relative to the control group. Next, we will discuss these results and their applied and theoretical implications in detail.

**Long-term verbal memory performance in dysarthria**

The literature on dysarthria focuses mainly on their speech deficits, rather than their cognitive performance. The limited number of studies that evaluated memory in dysarthria tested working memory abilities, with conflicting results. Baddeley and Wilson (1985) reported no working memory deficits (but note the limited number of participants). However, other studies documented decreased verbal working memory abilities (e.g., Ravizza et al., 2006). Consistent with these latter studies, the current data show that long-term verbal memory is impaired in dysarthria (lower recognition rates for silent as well as for aloud words) relative to healthy controls, despite the intact cognitive abilities of the participants.

Let us first look at the recognition of silent words. In contradistinction to our hypothesis, the dysarthric participants recognised fewer silent words than the healthy participants did. This result suggests that motor speech difficulties can affect the maintenance of verbal information in memory. Such memory difficulties may be related to an impaired articulatory rehearsal (silent verbal repetition) process. According to Baddeley’s model of working memory (Baddeley, 2000, 2003; Baddeley & Hitch, 1974), the sub-vocal rehearsal system assists in keeping stimuli in short-term memory storage. The articulatory rehearsal process is assumed to “refresh” information maintained within a phonological store, allowing it to be preserved in memory for longer periods. Reduced ability of articulatory rehearsal may lead to working memory reduction, which in turn may negatively affect long-term memory.

Presumably, impaired speech abilities may be related to a faulty phonological working memory. Various aspects of phonological processing (e.g., vision-to-sound conversions, sub-vocal rehearsal and lexical access) were found to differ between persons who stutter and fluent controls (Byrd, McGill, & Usler, 2015). For example, adults who stutter were slower and less accurate than fluent adults in a word jumble task, requiring them to silently manipulate scrambled letters to form a real word (McGill, Sussman, & Byrd, 2016). Although speech production is not involved in this task, rather the ability to sub-vocally rehearse the possible real words, persons who stutter show difficulties in its performance.

Similarly, dysarthric adults may show reduced sub-vocal rehearsal abilities. This possibility was offered by Cubelli and Nichelli (1992), evaluating anarthric patients (with a total loss of speech). The authors proposed that either the articulatory rehearsal processes are impaired, or the articulatory recoding processes (involved in transferring visually presented material into an articulatory form for better retention) are decreased. Different conclusions were drawn by Foley and Pollatsek (1999), who examined anarthric and dysarthric individuals. They claimed that accurate phonological coding of text can occur in the absence of speech, yet noted significant individual differences in phonological coding during short-term memory tasks.
The current finding, a reduced memory for silent items for the dysarthric group relative to the controls, supports Cubelli and Nichelli’s (1992) notion. Namely, impaired speech associates with reduced sub-vocal rehearsal abilities. A sub-vocal rehearsal strategy seems useful to healthy individuals, since it allows phonological coding of visual material. However, if the phonological store is damaged, then it is possible that a sub-vocal rehearsal strategy would be inefficient and forsaken (Vallar & Baddeley, 1984). Ravizza et al. (2006) concluded that attempting to use verbal strategies might be less effective in improving performance for dysarthric patients, since their verbal working memory ability is impaired.

Having explained the recognition pattern of silent words, let us discuss now memory performance for aloud words. The results indicate that vocal production substantially improved recognition in dysarthric patients, as memory for aloud words was higher than for silent words, a PE. Possibly, vocalisation compensates for their reduced sub-vocal rehearsal abilities, assisting verbal memory, resulting in a larger PE. In other words, due to their impaired speech production mechanism, dysarthric adults actually benefitted from vocalisation more than healthy individuals.

**Vocalising as a “desirable difficulty” for dysarthric patients**

The speech deficits that characterise dysarthria (namely, slurred, soft and effortfull speech) may result in less distinctive responses, hence a reduced memory for aloud words (smaller PE, similar to the pattern observed with whispering productions, Forrin et al., 2012). In contrast, the high effort of vocalisation may serve as a desirable difficulty, increasing memory for aloud words (larger PE, comparable with that of saying aloud loudly, Quinlan & Taylor, 2013). The results revealed that the size of the PE for the study group was significantly larger relative to the controls. Namely, although speech production (articulation) mechanism of the dysarthric patients is impaired, resulting in distorted tactile and auditory feedback (e.g., less effective encoding procedure), the benefit they gained from vocal production was greater.

This may hint that for the dysarthric patients, the aloud words (although less intelligible) were even more unique and distinct relative to the backdrop of silent words. Presumably, demanding or unusual vocal productions (e.g., singing, distorted speech) lead to significant memory benefit, due to their high levels of difficulty and effort (the desirable difficulties account; Bjork, 1994, 1999). For disarthric patients, vocal production is more challenging and effortful than it is for healthy individuals; hence, it provides greater memory benefits. In other words, the effort of vocalisation pays off, resulting in a deeper memory trace, and better memory performance (for a related pattern in cochlear implant users, see: Taitelbaum Sweek, Icht, & Mama, in press).

**Clinical implications**

Hitherto, long-term memory abilities in dysarthria have not been tested, and this study introduces novel evidence for such impairments. Memory for both aloud and silent words was found to be decreased in the study group relative to controls. However, the reduced performance for dysarthric individuals was expressed mainly in the silent words; they recognised only half of the silent words compared to controls. The difference in performance for aloud words between the two groups was smaller. This may
suggest that vocalisation (saying aloud) assists dysarthric patients’ memory, probably compensating for their reduced sub-vocal abilities. Vocal production enables better word recognition, approaching that of healthy controls. Thus, vocalisation may be considered a mnemonic for this population.

Dysarthric patients tend to be less active participants in conversations (Comrie, MacKenzie, & McCall, 2001) due to their speech difficulties. The current results indicate that therapists and caregivers should encourage them to speak. Some intervention techniques for dysarthria include non-traditional therapies, such as social support or stimulation (e.g., art, dance, informal unstructured communicative interactions). Vocalisation may be encouraged during such activities, in order to improve retention and performance. In everyday practice, caregivers and therapists talk with stroke patients during intervention sessions, verbally instructing them, provide feedback on progress, or provide reassurance to reduce anxiety (Bowen et al., 2001). Asking dysarthric patients to vocalise such given instructions may assist remembering them, making sure that the instructions are better understood and followed. For example, vocal production may enhance patients’ compliance with their medicine administration protocol. Saying aloud the names of individual medications, the doses to be taken and their schedule may assist in better remembering, reducing the number of medication errors.

CVA often results in movement and mobility problems (e.g., hemiplegia). Many patients experience difficulties in walking and transferring (moving from a bed to a chair or from a wheel chair to a toilet seat). Physiotherapists and occupational therapists assist such patients by teaching them sequences of motor steps that enable safe and easy movements (e.g., “first advance the quadruped cane and then the affected leg”). Vocalisation of a list of movements may assist in remembering them, hence reducing the degree of risk of injury to the patient, and regaining functional independence for ADL (Nair & Taly, 2002).

Another example of using vocalisation in clinical settings is related to dysphagia treatments. Many dysarthric patients suffer from chewing and swallowing disorders, thus have difficulties ingesting normal food and liquids (Ramsey, Smithard, & Kalra, 2003). Upon hospital discharge of a dysphagic patient, speech-language pathologists often provide a list of recommendations to decrease the risk of dysphagia-related complications (e.g., aspiration pneumonia; Kind, Anderson, Hind, Robbins, & Smith, 2011). Such recommendations often include dietary restrictions (e.g., ground or crushed food, no foods with mixed consistencies), postural and compensatory techniques (e.g., lean to left while eating, tilt head to right while eating), and meal pacing and sizing (e.g., ½ tsp. bolus size). Encouraging a patient to vocally produce her specific recommendations list may assist in remembering them, increasing oral intake and enabling the patient to safely maintain adequate nutrition (Wendin et al., 2010).

Since dysarthric speech may be difficult to understand (e.g., it is slurred, slow, with abnormal pitch and rhythm), caregivers and family members are advised to adopt strategies to better communicate with the patients. In some cases, asking yes/no questions or having the patient write his or her messages are encouraged (ASHA, 2016). The patients themselves are advised to use alternative communication methods, such as pointing or gesturing, in case they are not well understood. However, the current results indicate that the effort of saying aloud is worthwhile, assisting in cognitive (memory) performance.
Disclosure statement

No potential conflict of interest was reported by the authors.

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