

## High-level language and phonological awareness abilities of children following management for supratentorial tumour: Part II

Kimberley M. Docking, Bruce E. Murdoch, Elizabeth C. Ward

School of Health and Rehabilitation Sciences, The University of Queensland, Brisbane, Queensland, Australia

**Key words:** *supratentorial, tumour, children, high-level language*

### SUMMARY

**Background.** *Limited information is available regarding the impact of childhood tumour on the cerebral hemispheres and supratentorial cranial fossa. However, a recent study found that children managed for a tumour located in this region may demonstrate reduced general language abilities. However, the indirect or direct impact of a tumour in this region on higher-level language abilities in childhood is at present largely unknown.*

**Materials and methods.** *The present study examined the higher language and phonological awareness abilities of five children treated for supratentorial tumour ranging in age from seven to fourteen years in age. Assessments included measures of receptive and expressive semantic abilities, inferencing, figurative language, and problem solving, as well as a comprehensive pre-literacy test.*

**Results.** *As a group, reductions were evident in problem solving, and in the ability to receive and decode content of high-level language when compared to a group of age- and gender-matched peers. At an individual level, only two of five children managed for supratentorial tumour demonstrated language deficits. These two cases were noted to be the same children previously identified as also having general language deficits. More widespread findings were noted in phonological awareness, with four of the five children previously managed for supratentorial tumour demonstrating weaknesses in one or more areas.*

**Conclusions.** *Findings demonstrated that weaknesses in general language ability in children managed for supratentorial tumour may indicate higher-level language difficulties. Language abilities beyond general measures of language should be monitored, as well as long-term consideration of phonological awareness abilities in this population.*

### INTRODUCTION

In our previous study published in the last issue of *Acta Neuropsychologica* (Docking et al. 2003) addressing general language abilities of children, a reduction in both general expressive language skills and the total overall language score was reported when comparing a group of six children treated for supratentorial tumour with a group of individually matched peers. Deficits at an individual case level were evident in two cases, with disturbances to expressive language and syntax observed in the general language performance of a child who had undergone surgical treatment for a left parietal astrocytoma and reduced semantic abilities in a child who had been treated for an optic nerve glioma. The remaining four cases with largely similar profiles in treatment and various tumour locations that included similar sites to those with language deficits, demonstrated intact general language abilities. A series of factors were considered as possible factors influencing the performances of the six cases, such as the long-term presence of the tumour prior to diagnosis, the young age at diagnosis and treatment, and the varied duration post treatment of the assessment (Docking et al. 2003). The other possibility raised in the

previous paper in discussion of the differential patterns observed across the cases, was the issue of sensitivity of the assessment battery. It is possible that the assessments used may have failed to detect individual language subtleties, with scope limited to the evaluation of general language abilities for each participant.

In their study of language function in children following treatment for posterior fossa tumour Murdoch and Hudson-Tennent (1994) included a test of high-level language abilities, the Test of Language Competence (TLC), in their language assessment battery. This study revealed that of the eleven children administered the TLC, four cases exhibited reduced high-level language skills and two were unable to complete the test. Of the four cases with demonstrated high-level language impairments, three children performed more than two standard deviations below the mean overall. However, two of these children (including one with significant high-level difficulties), had demonstrated intact general language abilities as measured by the Test of Language Development (TOLD) series. The remaining two children with significant high-level language difficulties, however, demonstrated general language abilities that were significantly reduced. Considering the potential subtle nature of language deficits which may occur post tumour, there is a possibility that high-level language impairment in this group of children with brain tumour may not have been identified by the employment of general language assessments.

No study to date, however, has specifically investigated the presence of high-level language deficits in children treated for supratentorial tumour, despite documented high-level language impairments in children with posterior fossa that were reported to be inconsistent with general language ability (Murdoch & Hudson-Tennent 1994). The evaluation of high-level language skills in the supratentorial population may, therefore, provide further indication of the language abilities that may present in these children, assisting researchers and clinicians in providing a more comprehensive profile of the potential areas of subtle deficits that may occur as a result of supratentorial tumor in childhood.

The impact of paediatric supratentorial tumour on pre-literacy phonological awareness abilities has also not been specifically addressed, despite reports of deficits in understanding letters, syllables, and words, and later reading and writing difficulties, in children with acquired aphasia resulting from cerebral lesions of varied aetiologies inclusive of brain tumour (Alajouanine & Lhermitte 1965; Carrow-Woolfolk & Lynch 1982; Hécaen 1976; Satz & Bullard-Bates 1981; VanDongen, Loonen, & VanDongen 1985). An investigation by VanDongen et al. (1985) of three children who exhibited evidence of trauma to the left temporal region resulting from head injury or haematoma, revealed disturbances to reading, writing and spelling. A study of eight children with lesions localized to the left hemisphere (resulting from brain injury, haemorrhage, and infarct), revealed severe reading deficits in five patients, mild difficulties in two, with performance inadequately documented for the remaining child. Severe deficits in spelling were also noted in three cases. All children also required access to special education. As it is widely indicated that weaknesses in phonological awareness abilities lead to later literacy difficulties (Kahmi & Catts 1991; MacDonald & Cornwall 1995; Stackhouse & Wells 1997), it is suggested that an impairment of literacy in these populations may represent underlying limitations in foundation phonological awareness skills.

It was the aim of the present study to investigate both the high-level language and phonological awareness abilities of children treated for supratentorial tumour. Such an examination in this population will address the possible presence of high-level language impairment in this group of children and provide a comprehensive profile to assist researchers and clinicians in accounting for these possible deficits. Phonological awareness abilities of these children will also be examined to document the possible impact that a tumour in the supratentorial area has on these skills in order to anticipate any difficulties that may manifest in the literacy abilities of school-aged children.

#### **MATERIAL AND METHODS *Participants***

The high-level language and phonological awareness abilities of a group of five of the six participants treated for supratentorial tumour (Cases 1, 2, 3, 4, and 5) described by Docking et al. (2003) in Part I were examined (mean age = 10.33 years, standard deviation = 2.89 years), in addition to the age and gender matched control participants (mean age = 10.43 years, standard deviation = 3.00 years). The

biographical details are provided in Table 1. Due to age, Case 6 and her individually matched control participant could not be administered the assessments of high-level language or phonological awareness, and therefore has not been included in the present analysis.

### Procedure

All ten participants and their respective parental guardians were provided with written and verbal information outlining the nature of involvement in the study. Consent was then obtained from both parties in each case. Each of the five participants treated for supratentorial tumour and their age- and gender-matched peers were administered a battery of standardized assessments designed to examine higher-level language function and phonological awareness. The assessment battery included: the Test of Problem Solving - Elementary (Revised) (TOPS-Elementary) (Zachman et al. 1994) or the Test of Problem Solving - Adolescent (TOPS-Adolescent) (Zachman et al. 1991), the Test of Word Knowledge (TOWK) (Wiig & Secord 1992), the Test of Language Competence - Expanded (TLC-E) (Wiig & Secord 1989), and the Queensland University Inventory of Literacy (QUIL) (Dodd et al. 1996).

The age of each participant treated for supratentorial tumour and their individually matched peer determined the version or age group level that was completed for each of the high-level language assessments. In addition to their respective peers, Cases 1, 2, 3, and 4 completed the TOPS-Elementary, while Case 5 completed the TOPS-Adolescent. On both the TOWK and the TLC-E, Cases 1 and 2 and their matched control participants completed Level 1, and Cases 3, 4, and 5 and their matched control participants were administered Level 2. The visual requirements of Case 4 were also accounted for in assessing levels of high-level language and phonological awareness ability.

Table 1. Biographical data of participants treated for supratentorial tumour

Case	Gender	Age <sup>a</sup> at assessment	Age <sup>a</sup> at diagnosis	Time <sup>a</sup> posttreatment	Tumour type	Tumour location	Treatment	Extent of Surgery	Radiation Dosage	Chemo-therapy drugs
1	F	7;4	5;1	4;2	Juvenile Pilocytic Astrocytoma	Left parietal lobe	S	Near-total	-	-
2	M	7;7	6;2	0;6	Germl cell	Furcal region	R, C	-	72Gy	Cisplatin, etoposide, cyclophosphamide, bleomycin, ifosfamide, amifostine
3	M	11;1	10;2	0;9	(a) LG glioma (b) optic nerve glioma	(a) Upper lateral plane (b) Optic nerve	S	Endoscopic 3 <sup>rd</sup> ventriculectomy	-	-
4	F	11;7	5;8	6;11	Pilocytic Astrocytoma	Optic nerve	S	Subtotal	-	-
5	M	14;1	10;7	3;6	Ganglioglioma	Left frontal lobe	S	Total	-	-

Note: <sup>a</sup> = Age and time presented in years and months; \* = age since diagnosis; LG = low-grade; S = surgery, R = radiotherapy; C = Chemotherapy; - = not applicable; Gy = grays.

## RESULTS

### Group analysis

The high-level language and phonological awareness abilities of five participants treated for supratentorial tumour and five control participants matched for age and gender were examined. As both Case 5 and their individually matched peer were in Grade 10 at the time of testing and above the upper limits of the normative data provided for the QUIL (Grade 1 to Grade 7), individual standard scores were calculated based on the Grade 7 normative data. Results yielded by the QUIL are provided in

separate subtest scores, as this assessment does not make provision for an overall score to be calculated.

Homogeneity of variance was tested across all high-level language parameters using Levene's Test for Equality of Variances, and was found to be non-significant ( $p > 0.05$ ) across all high-level language parameters and two subtests of the QUIL. Eight subtests of the QUIL were considered significant ( $p < 0.05$ ) for homogeneity of variance. As small group numbers also existed, non-parametric tests were adopted for all analyses. Consequently, Mann-Whitney U tests were employed to determine the presence of statistically significant discrepancies across all parameters of the high-level language and phonological awareness between the five participants treated for supratentorial tumour and their age- and gender-matched controls. These results are summarized in Table 2. Due to the multiplicity of subtests ( $n = 10$ ) comprising the QUIL, a stringent alpha level of  $p < 0.01$  (Shearer 1982) was applied for this assessment only. For all other assessments, an alpha level of  $p < 0.05$  was adopted.

Statistical measures applied to results of the high-level language abilities and phonological awareness skills of a group of five children treated for supratentorial tumour and an individually matched control group revealed significantly reduced performance on the TOPS and the Receptive Composite Score of the TOWK. At the level of group analysis, however, individual variation is often unaccounted for in populations of children treated for brain tumour (Murdoch & Hudson-Tennent 1994). Therefore, it was considered necessary to examine each of the five cases treated for supratentorial tumour on an individual basis in order to determine the presence of specific signs of language impairment or reduced phonological awareness abilities that may have been masked by group analysis. Specific subtest knowledge and indepth analysis of subtest performance can also be gained through individual analysis of each child. Individual analysis revealed high-level language deficits in the profile of Cases 1 and 4, and weakness in phonological awareness in four of the five children examined (Cases 1, 2, 3, and 5). Each child's performance is represented in standard scores that are compared to the normative data on each standardized assessment.

*Table 2. Supratentorial tumour and control group analysis: Means (M), standard deviations (SD), and Mann Whitney U comparisons for the Test of Problem Solving (TOPS), Test of Word Knowledge (TOWK), Test of Language Competence – Expanded (TLC-E), and Queensland University Inventory of Literacy (QUIL)*

Parameter	Supratentorial group (n = 5)		Control group (n = 5)		Mann Whitney U	Asymp. Sig. (2-tailed)
	M	SD	M	SD		
TOPS	88.00	16.80	109.60	7.09	2.9	0.03*
<b>TOWK</b>						
Receptive Composite	96.80	14.03	110.80	7.23	3.0	0.04*
Expressive Composite	96.60	20.79	111.80	9.66	7.0	0.25
Total Score	96.40	18.56	113.40	8.62	4.5	0.09
<b>TLC-E</b>						
Interpreting Intents	90.60	14.89	109.00	12.60	4.5	0.09
Expressing Intents	90.60	19.23	112.60	16.62	4.5	0.09
Total Score	89.80	16.86	113.60	17.11	4.0	0.07
<b>QUIL</b>						
Nonword spelling	10.00	3.85	15.20	7.79	2.5	0.03
Nonword reading	9.40	2.61	12.60	7.82	4.0	0.07
Syllable identification	10.40	3.82	12.00	6.71	5.5	0.12
Syllable segmentation	9.60	4.46	10.40	7.67	5.5	0.13
Spoken Rhyme	9.00	4.18	11.40	6.56	5.5	0.13
Visual Rhyme	9.40	2.67	11.90	6.45	3.5	0.04
Spoonerisms	9.40	4.12	13.20	7.10	5.5	0.10
Phoneme detection	9.60	4.42	13.40	6.86	5.5	0.05
Phoneme segmentation	11.40	4.95	15.60	8.89	5.5	0.52
Phoneme manipulation	8.40	3.85	11.60	6.86	6.5	0.16

Note: \* =  $p < 0.05$ ; p significant at  $< 0.01$  for QUIL.

## Individual Analysis

### Case 1

Case 1 underwent a partial resection of a large juvenile pilocytic astrocytoma in the left parietal region at the age of three years one month, leaving some residual tumour medially against the thalamus. General language assessments previously documented by Docking et al. (2003) revealed intact overall receptive skills and receptive vocabulary abilities in the presence of reduced expressive language, particularly in the area of syntax, in addition to naming skills considered below the normal range. At the age of seven years four months, Case 1 participated in testing for high-level language and phonological awareness abilities. It was noted that high-level expressive language abilities on both the TOWK and the TLC-E (Level 1) were below the normal range (see Table 3). At the subtest level it was observed that the Word Definitions subtest of the expressive component of the TOWK was significantly below the normal range at two standard deviations below the mean. This subtest assesses the child's ability to provide definitions that include category membership and semantic feature knowledge (Wiig & Secord 1992). In the Expressing Intents section of the TLC-E, the Ambiguous Sentences subtest was also considered below the normal range. This subtest of the TLC-E addresses the ability to interpret sentences with ambiguities arising from multiple-meaning words or phrases (Wiig & Secord 1989). Performance on the QUIL indicated performance on the following subtests to be below the normal range: Nonword Spelling, Spoonerisms, Phoneme Detection, Phoneme Manipulation. Nonword Spelling requires the child to spell nonsense words they have not heard prior to assessment in order to tap into foundation phonological awareness abilities, without reliance on sight word knowledge. The Spoonerisms subtest requires a child to detect and manipulate the initial phoneme in two words in order to swap them to create two new words. On the Phoneme Detection subtest, the child is required to detect the one word from a group of four, which contains a different positional phoneme to the remaining presented words. Phoneme Manipulation requires the child to produce the word that results when a given phoneme is taken out of a given word.

#### *Case 2*

Case 2 underwent both radiotherapy and chemotherapy as treatment for a germ cell tumour in the pineal region (see Table 1). Six months later, at the age of seven years seven months, high-level language and phonological awareness assessments were administered. General language abilities were previously considered intact in Part I by Docking et al. (2003). Abilities demonstrated by assessments of high-level language was considered to be intact, with both the Receptive and Expressive components of the TOWK deemed more than one standard deviation above the mean (see Table 3). However, performance on three out of ten subtests on the QUIL (Spoken Rhyme, Spoonerisms and Phoneme Manipulation) were considered two or more standard deviations below the mean.

#### *Case 3*

As outlined in Table 1, Case 3 was aged ten years two months when diagnosed with a low grade glioma in the upper tectal plate and an optic nerve glioma. An endoscopic third ventriculostomy was subsequently performed to relieve hydrocephalus. Eleven months later, testing for the present study was carried out. General language testing revealed intact abilities, as previously noted by Docking et al. (2003). Performance across high-level language assessments in the present analysis was considered to be well within the normal range (Table 3). However, both the Spoken Rhyme and the Phoneme Detection subtests of the QUIL were noted to be two standard deviations or more below the mean.

#### *Case 4*

Case 4 was treated with a subtotal resection for a pilocytic astrocytoma in the suprasellar / optic nerve region at the age of five years eight months, as outlined in Table 1. At the age of eleven years seven months, Case 4 was administered the assessments for the current analysis. General language assessments previously reported in Part I (Docking et al. 2003) revealed a specific weakness in a receptive semantic task, and reduced receptive vocabulary skills. Performance across all assessments of high-level language were, however, considered below the normal range, except for the Figurative Usage subtest of the TOWK (see Table 3). All phonological awareness abilities as assessed by the QUIL, however, were deemed to be within or above the normal range.

#### *Case 5*

At the age of ten years seven months Case 5 underwent total removal of a left frontal ganglioglioma (as summarized in Table 1). Three years six months following surgery, at the age of fourteen years one month, testing of high-level language and phonological awareness abilities was carried out. As reported in Part I, general language testing indicated intact abilities across all parameters. Similarly, all high-level language skills were observed to be within the normal range (see Table 3). While most phonological awareness abilities were also deemed to be within the normal range, performance on the Phoneme Detection subtest was noted to be more than one standard deviation below the mean.

*Table 3. Individual high-level language and phonological awareness assessment results (represented in standard scores) of Cases 1-5 with supratentorial tumour on the Test of Problem Solving (TOPS), Test of Word Knowledge (TOWK), Test of Language Competence – Expanded (TLC-E), and Queensland University Inventory of Literacy (QUIL)*

Tests	Case 1	Case 2	Case 3	Case 4	Case 5
TOPS	86	103	93	55*	103
TOWK					
Receptive Composite	88	118	100	51*	87
Synonyms # / Word Opposites#	8#	15#	11*	6**	11*
Figurative Usage # / Receptive Vocabulary #	7#	10#	9*	7*	8*
Expressive Composite	78*	123	106	73*	103
Word Definitions	4*	14	10	6*	10
Multiple Contexts # / Expressive Vocabulary #	8*	14#	12	4*	11
Total	82*	122	103	75*	100
<b>TLC-E</b>					
Interpreting Intent	9*	103	91	65*	97
Listening Comprehension: Making Inferences	11	10	9	4*	6
Figurative Language	8	11	8	3*	11
Expressing Intent	79*	100	94	65*	115
Ambiguous Sentences	5*	10	10	5*	10
Oral Expression: Recreating Sentences # / Speech Act#	7#	10#	8*	4**	9*
Total	86	103	91	65*	100
<b>QUIL</b>					
Nonword spelling	8*	7	14	12	14
Nonword reading	7	7	9	13	11
Syllable identification	9	8	12	12	11
Syllable segmentation	9	10	8	10	12
Spoken rhymes	10	8*	4*	12	11
Visual rhymes	11	9	8	7	12
Spoken rhymes	8*	4*	11	13	13
Phoneme detection	6*	11	5*	14	6*
Phoneme segmentation	10	10	13	14	10
Phoneme manipulation	6*	4*	11	13	8

Note: # = Level 1 subtest variation; \* = Level 2 subtest variation; \* = below normal range (Standard scores in Italic; normal range 85 - 115; Subtest standard score normal range = 7-13); \*\* normative data not available for this child.

## DISCUSSION

At a group level, findings revealed the performance of a group of five children treated for supratentorial tumour was reduced when compared to their individually matched peers on the Test of Problem Solving (TOPS-Elementary / TOPS-Adolescent). The TOPS evaluates problem solving and language-based critical thinking in children (Zachman et al. 1991; Zachman et al. 1994). Critical thinking abilities are based on language strategies using logic and experience, and include a broad range of critical thinking skills such as clarifying, analyzing, generating solutions, evaluating, and affective thinking. As language is the foundation of critical thinking, involving receptive, processing, and expressive abilities, limitations in any of these areas may result in the use of incomplete or inaccurate information in making judgements, an inability to transfer ideas to new contexts or to express thoughts, opinions, and ideas clearly and precisely, and difficulty formulating and requesting information (Zachman et al. 1991; Zachman et al. 1994). These problem solving skills and critical thinking skills, as assessed by the TOPS, are essentially based on higher-level semantic abilities, as well as some involvement of cognitive processing components. Therefore, it is this area of high-level language that appears reduced in children treated for supratentorial tumour in the present study at a group level compared to the control group.

In addition to reduced performance on the TOPS assessment, the group of five children treated for

supratentorial tumour performed below their peers on the receptive language component of the Test of Word Knowledge (TOWK). The knowledge of words and concepts are considered essential aspects in cognition, intelligence, and verbal reasoning (Wiig & Secord 1992). The TOWK was employed to examine a more in-depth and higher level of semantic ability in both the receptive and expressive components of language than an assessment of general language may address. A breakdown in the receptive area of this level of skill represents a reduced ability to receive and decode the content of high-level language (Wiig & Secord 1992).

As both the TOPS and the TOWK represent high-level semantic abilities, it is evident that children treated for supratentorial tumour in the present study exhibited reduced ability in this area, particularly in the receptive component of decoding and processing as demonstrated by difficulty in the receptive component of the TOWK. Children with difficulties in the area of high-level semantics commonly assume others' thoughts and opinions are correct without examining the information and their own opinions (Zachman et al. 1991; Zachman et al. 1994). They therefore require experience in thinking individually and in using the language skills necessary for critical thinking (Zachman et al. 1991; Zachman et al. 1994). Particular difficulty in the area of semantics is also documented in both paediatric head injury populations and studies examining acquired aphasia in children with brain trauma of varied aetiologies (Carrow-Woolfolk & Lynch 1982; Chapman, Levin, & Lawyer 1999; Hécaen 1976; Jordan & Murdoch 1990; Jordan et al. 1996; Jordan, Ozanne, & Murdoch 1988; Satz & Bullard-Bates 1981; VanDongen et al. 1985).

While results indicated that as a group, children treated for supratentorial tumour performed significantly below a group of individually matched control participants with respect to both problem solving and receptive high-level language in the area of semantics, it is acknowledged that only one individual case demonstrated scores below the normal range on both of these assessments (Case 4). Additionally, just two of the five children examined demonstrated evidence of high-level language deficits (Cases 1 and 4), with the remaining three children (cases 2, 3, and 5) performing within the normal range across all measures. It is, therefore, suggested that group findings again must be interpreted with caution due to small group numbers. It is also noted that the overall group means of these components fall within the normal range of 85-115 according to the test normative data. Thus, group findings may be described as subclinical, in that while mean performance is considered within the normal range, it remains significantly below performance of the control group. Subclinical findings were also described by Jordan and colleagues (Jordan & Ashton 1996; Jordan & Murdoch 1990, 1994; Jordan et al. 1995; Jordan et al. 1988; Jordan, Ozanne, & Murdoch 1990) and Ewing-Cobbs et al. (1987) who documented the language abilities of children following head injury.

Although it was predicted that high-level language impairments may present in children treated for supratentorial tumour, regardless of the presence of general language difficulties, it was found that the only children to exhibit high-level language difficulties (Cases 1 and 4) in this investigation were those who had also experienced some areas of difficulty in general language, as documented in Part I by Docking et al. (2003). In the present paper, it was evident that Case 1 experienced particular difficulty on the expressive components of both the TOWK and the TLC-E, which were both noted to be below the normal range. This finding is similar to performance on the general language assessments reported in Part 1 (Docking et al. 2003), in that Case 1 also experienced difficulty on the Expressive Language component of the CELF-3. Following this pattern of an overall weakness in expressive language, Case 1 was also noted to experience difficulty on the expressive TOWK subtest, Word Definitions, in the present analysis. This subtest addresses high-level language abilities in the area of expressive semantic features and relations, including vocabulary items and concepts. It would be expected, however, that due to a demonstrated weakness in general naming abilities reported by Docking et al. (2003) in Part I, significant difficulty in performance on this task requiring higher-level descriptive and semantic skills, would be experienced. As was established by Docking et al. (2003), a reduction of expressive language abilities has been previously documented in studies of acquired aphasia resulting from brain lesions in children, particularly in children with left hemisphere lesions (Alajouanine & Lhermitte 1965; Carrow-Woolfolk & Lynch 1982; Satz & Bullard-Bates 1981; VanDongen et al. 1985) and supports this notion of weak expressive language skills in both general and high levels in children treated for supratentorial tumour.



Case 4, however, who exhibited difficulty in the specific area of receptive semantics and word meanings at a general language level (Docking et al. 2003), experienced significant difficulties across all parameters of high-level language, with particular difficulty in problem solving on the TOPS. Since all high-level language tasks require an advanced level of competency in semantic language skills, it is suggested that a more overt impact on high-level language abilities occurs where performance is reliant on weak foundation skills in the area of semantics. It cannot be ignored, however, that the global impairment in high-level language experienced by Case 4 may also reflect higher cognitive-communicative deficits and as such, a cognitive assessment would reveal greater insight into such a presentation.

Contrary to one previous report of reduced high-level language skills in the presence of intact general language abilities (Murdoch & Hudson-Tennent 1994), it was noted in the present study that children without difficulties in general language did not exhibit difficulties in high-level language. In fact, the present analysis revealed that intact general language abilities indicated intact high-level language abilities. Therefore, it is suggested that a need exists for larger group investigations of this population controlling for time post treatment in order to determine if isolated high-level language deficits are indeed a feature in this population at greater time post-treatment into later language development. This is important given the reported potential for effects from chemotherapy and radiotherapy to occur at lengthy periods post-treatment (Sands et al. 1998). With such limitations and the small sample represented in the current study, however, such findings against isolated deficits are certainly not considered conclusive.

At an individual level, four of the five children (Cases 1, 2, 3, and 5) treated for supratentorial tumour assessed on the QUIL exhibited some areas of phonological awareness below the normal range. While Case 5 performed below the normal range on one subtest (Phoneme Detection), it is acknowledged that while specific difficulty may have been experienced for this particular skill, fatigue or another external factor may have also contributed to this one mildly reduced score amongst intact abilities demonstrated across all areas of general (Docking et al. 2003) and high-level language abilities, as well as other phonological awareness skills. While Case 3 demonstrated performance below the normal range on two subtests, both scores appeared significantly reduced, and may reflect specific difficulties in skills represented by the Spoken Rhyme subtest and the Phoneme Detection subtest. Similarly, Case 2 demonstrated significantly reduced performance on the Spoken Rhyme, Spoonerisms, and Phoneme Manipulation subtests. Case 1, however, experienced more widespread areas of mild weakness. Previous history noted phonological awareness delays at twenty-four months post surgical treatment, with only an emergent level of sound awareness in words evident. This earlier assessment also revealed an inability to identify rhyme, construct rhyming words, and determine the number of syllables in words. Thus, reduced ability in this area is commensurate with overall reductions in language.

While phonological awareness skills of children treated for brain tumour have not previously been reported, several authors have documented difficulties in the understanding of letters, syllables, and words (Alajouanine & Lhermitte 1965), as well as later literacy difficulties (with reports of reading and/or spelling difficulties), in populations of children with acquired language disorder resulting from various brain trauma (Alajouanine & Lhermitte 1965; Cooper & Flowers 1987; VanDongen et al. 1985). Evidence from studies noting the impact of phonological awareness abilities on literacy skills (Kahmi & Catts 1991; MacDonald & Cornwall 1995; Stackhouse & Wells 1997) suggests that findings in such studies noted above may therefore reflect an impairment of the underlying basic pre-literacy phonological awareness abilities. Cranberg et al. (1987) documented severe reading and spelling deficits in children with left hemispheric lesions, with reading and writing disturbances also noted in studies by Hécaen (1976) and Carrow-Woolfolk and Lynch (1982). Reduced reading and spelling performance was noted in three of fifteen children in a study by Cooper and Flowers (1987), who had experienced either a brain infection or an anoxic event, in addition to a further three children with deficits in spelling (with aetiologies of brain infection, left-sided cerebrovascular accident, and closed head injury). A significant disturbance of reading ability and specifically, the ability to decode letters, syllables and words, was noted in eighteen out of thirty-two children with acquired aphasia in the study by Alajouanine and Lhermitte (1965). Three cases investigated by VanDongen et al. (1985) with a reported left temporal haematoma also demonstrated evidence of initial and residual reading and writing difficulties post

treatment. In contrast, however, Sands et al. (1998) found average performance on measures of reading and spelling by all six children examined following chemotherapy treatment for brain tumour. It was noted in the general language profile of Case 1 reported by Docking et al. (2003) in Part I, that a weakness in the area of sentence structure was demonstrated. It was suggested that difficulty in this area may influence pre-reading, early reading, and early writing activities (Semel, Wiig, & Secord 1995). While pre-literacy skills in the current analysis were primarily assessed at a phonological awareness level, it is nevertheless suggested that poor performance on both areas of phonological awareness (as noted by Docking et al. 2003) and syntactic abilities at a sentence level may indicate a bilateral relationship in that weaknesses in either area may impact on the other to some degree. Further research is required to examine the impact of weaknesses in pre-literacy skills on later literacy development specifically in children following supratentorial tumour. While disturbances in these skills may represent resultant impairments post surgery, it is also important to consider that children undergoing management for supratentorial tumour often experience long periods of hospitalization as well as commonly attending medical and associated appointments during school hours. Therefore, in the absence of pre-morbid function data, it is impossible to determine to what extent the difficulties demonstrated by reduced performance on assessments such as the QUIL may have also been impacted by these external factors.

## **CONCLUSION**

The high-level language and phonological awareness abilities observed in children treated for supratentorial tumour in the present study indicated that as a group, a pattern of reduced problem solving and ability to receive and decode the content of high-level language was observed in comparison to children who did not undergo management of supratentorial tumour. At an individual level, however, only two of the five children treated for supratentorial tumour examined exhibited specific high-level language deficits, and were the same two children who had been previously identified by Docking et al. (2003) as having general language impairment. Consequently, it is suggested that areas of weakness evident in general language contributed to difficulties in high-level language in these children. Contrary to previous reports (Murdoch & Hudson-Tennent 1994), the present study therefore failed to identify high-level deficits without concurrent general language deficits. Difficulties in phonological awareness, however, were more widespread, with four of the five children examined demonstrating some areas of weakness. The present analysis of high-level language and phonological awareness skills in children treated for supratentorial tumour highlights the importance of monitoring these skills in children treated for supratentorial tumour, in addition to and beyond measures of general language.

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#### Correspondence to:

Dr Kimberley M. Docking  
School of Health and Rehabilitation Sciences, The University of Queensland  
Brisbane, Queensland 4072, Australia  
Ph: +61 7 3365 6161  
Fax: +61 7 3365 1877

Email: [k.docking@uq.edu.au](mailto:k.docking@uq.edu.au)

RECEIVED: 10 September 2003

ACCEPTED: 25 November 2003