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Visual Recognition Difficulties: Identifying Primary School Students' Directional Confusion In Writing Letters And Numbers

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Visual recognition difficulties: Identifying primary school learners' directional confusion in writing letters and numbers

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ABSTRACT

Background: *Occupational therapists often assess primary school learners for letter and number reversal tendencies using scales which require recognition of reversed letters and numbers; however, these scales do not generally look at learners' written production of letters and numbers to measure their reversal tendencies. This study aimed to determine whether learners reverse the same letters and numbers in reading and in writing.*
Method: *This study utilised the Richmond Reversal Rating (RRR) Scale to identify which language symbols 118 primary school learners found difficult to recognise as being reversed when reading a series of letters and numbers and writing 20 letters and nine numerals.*
Analysis: *Nonparametric correlations and parametric Chi-square statistics were used to investigate differences in the learners' reading recognition and written production.*
Results: *Letters and numbers reversed in recognition (reading) and writing were similar. Moreover, eleven letters and three numbers were identified as difficult to orientate on a page.*
Conclusion: *Explicit teaching to remediate letter and number reversals and font use are paramount to improving language symbol orientation.*

Key words: Written production, reading recognition, letter and number reversals, primary school learners

INTRODUCTION

Letter and number reversals occur in school learners' manual encoding tasks such as writing, and/or visual receptive tasks, when symbols are not recognised in the correct spatial arrangement[1,2]. Recognition of reversals made by learners is important, as it has been shown that learners who make reversal errors exhibit poor visual-motor skills and show a tendency towards poor visual perception, which hinders their progression in reading and general academic performance[1,3-7]. Academic performance is measured in terms of the quality of the learner's written work, which, in turn, not only directly influences the teacher's assessment processes, but ultimately the grade assigned to the learner's work[8].

Typically, such quality assessment processes are influenced by the legibility, alignment and orientation of the learner's letters and numbers, which may be affected by the way the learner forms and recognises letters and numbers[2,8]. In contrast, handwriting difficulties characterised by letter reversals may be associated with language deficits when learners who confuse letters such as "b" and "d" have phoneme association difficulties rather than visual perceptual difficulties[2,9]. For this reason, the association between letter and number reversal recognition and letter and number reversal production in writing should be acknowledged, to establish whether the reversals can be identified as visual left-right confusion or phoneme grapheme confusion, as this would influence intervention strategies used by occupational therapists.

Good letter and number recognition develops in a linear process as the learner's visual perception develops[10,11]. Thus, it would be reasonable to assume that, as this linear visual perceptual development occurs, learners are able to integrate the letter and number recognition skills equally well in tasks such as reading and writing[3,12]. In addition, some reversals and left-right confusion are associated with the normal development and maturation of the nervous system of learners up to the age of seven years[13,14]. However, such maturation, linear development and teaching strategies do not give clarity about the tendency to reverse letters or numbers in written and recognised text. As such, it is somewhat surprising that research has dismissed the importance of reversal tendencies in the development of writing and reading letters and numbers in the primary school years, when clinical and educational experience indicates a continued difficulty for some learners[15]. Consequently, teaching methods have traditionally relied on "letter families" as a grouping method of teaching letters[16], teaching letters by using the learner's name[17], following a phonics approach[18], simply allowing the learner to spontaneously begin writing letters or by using an integrated approach by which the letter sounds and formations are matched in the learning process and writing is incorporated into the initial letter recognition process[1,2,6,17]. Some research has shown that the letters that primary school learners continue to have difficulty producing and recognising do not comprise a single letter group or specific letters in the linear progression of learning[8,19].

It is generally accepted that primary school learners need to develop many prerequisite skills, including motor and eye-hand co-ordination, visual perception, letter perception (including the ability to recognise forms, likenesses and differences) and orientation to the printed language (including visual analysis of letters and words and right-left orientation), in order to write correctly and legibly[2,8]. In addition to perceptual learning for writing, the association of letter sound, formation and identification is involved in learning the distinctive features of letters, numbers and words. Handwriting requirements include starting points, finishing points, size constancy, slope consistency, orientation to baseline and letter and word spacing[2,8,20]. In addition, learners have to learn various font variations as there are several different fonts/scripts used in schools related to printed matter that is read, and written. The complexity of mastering different fonts representing the same letter or sound in printed or written script potentially provides a further confounding factor in establishing the tendency of learners to reverse letters or numbers in written and recognised text.

In this context, a letter or number reversal or directional confusion is regarded as the recognition of written symbols or the production of these symbols (such as letters or numbers) in the incorrect

Table 1: Comparison of letter difficulties or reversals found in research

Study #	Letters																								
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
1	a		c	D/d	E		g				K					P	q		s	t						z
2		b		d		f	g							n		p			s	t	u					
3	a						g		i	j	k			n			q			t	u				y	z
4		b	c	d					i	j		l				p	q		s	t						z
5							g				k	L			o		q			t	u	v	w	X		

Table contents compiled from: 1. Richmond[4], 2. Terepocki, Kruk & Willows[21], 3. Graham, Weinstraub & Berninger[8], 4. Current study in this report. The letters in row 5 refer to letters not attempted by a substantial number of children in the current study. Letters reflected in capitals represent the capital version of the letter in the studies.

orientation. For example: when a learner recognises or writes a "b" as a "d". This definition of a letter reversal is in agreement with other researchers who have identified confusing letter order, as in transcribing letters such as load/laod as being a different perceptual concept (sequencing)[2,5,8,21]. Recent research[5] has determined that the most difficult letter orientations for learners to identify are, in order of difficulty, P, D, K, E, c, s, t, d, a, g, q, z, (*Table 1*) and the most difficult numbers 4, 7, 9 and 3. These results coincide with Graham, Weinstraub and Berninger's[8] earlier finding that q, z, g, u, n, k, j, a, y, t, i (see *Table 1*) are the letters that learners find the most difficult to write legibly in the first three years of primary school and, the finding by Terepocki, Kruk and Willows[21] that learners with reading difficulties made more written errors in the orientation of the letters d, b, p, g, f, t, s, n and u (*Table 1*). This study aimed to extend this present limited understanding of reversals by investigating the hypothesis that learners reverse different letters when writing to those which they reverse when reading, and that these reversals decrease as they progress in their schooling.

METHOD

In this research, a cross-sectional correlational approach was used. All participants were exposed to two assessments at a single point in time for data collection. The correlations describe the relationship between written and recognised (read) text in order to answer the research question.

Participants

Approximately 400 learners were invited to participate in this research. From this population, the return rate of parental approval for research participation was 30%. The resulting research sample comprised of 118 learners (68 boys and 50 girls) aged 4 to 10 years (mean age 8.5 years) who attended one of four primary schools (two public and two private) in Perth, Western Australia. The learners were drawn from Pre-primary Year 4 grades (i.e., 11 Pre-primary [5 boys, 6 girls], 40 Year 1 [25 boys, 15 girls], 34 Year 2 [18 boys, 16 girls], 22 Year 3 [15 boys, 7 girls] and 11 Year 4 [5 boys, 6 girls]). The schools were located in middle socio-economic areas. Learners who had difficulty learning were not excluded. Learners with a physical disability which prevented them from producing a written output were excluded. Coincidentally, all volunteer participants in this study were right handed.

Procedures

Prior to the research being conducted ethics approval was obtained from the Human Ethics Committee of the administering institution and from the pertinent educational authorities. Four principals were approached and expressed willingness for their schools to participate in the research and sanctioned their teachers to distribute information letters and consent forms to the parents of learners in the Pre-primary Year 4. On receipt of a signed consent form arrangements were made with the individual teachers for the first author to test the learners. These tests were delivered in non-teaching times (e.g., silent reading and free play time) so as to not disrupt the learning programme. All students were tested over a five week period in October of the same year.

The learners completed the letter and number recognition assessments either individually or in groups of no more than four learners, depending on the number of participants to be tested in each class. The Richmond Reversal Rating (RRR)[19] was used to assess the learners' letter and number visual (read) recognition. This rating consists of a series of letters and numbers (both in isolation and in combination). All learners were asked to identify letters and numbers that were in the reversed configuration when these letters and numbers were presented in isolation. In addition, learners were asked to identify the words or calculations which contained a reversed letter or number after examining the words and calculations. The RRR Scale[19] was created using the Victorian Modern Cursive font, which is similar to the Nelson font, pre-cursive font and D'Nealian fonts which are commonly used to teach handwriting to learners in school. In addition to completing the RRR Scale, the learners were also asked to write the alphabet in lower case, numbers 0-9 and, 20 dictated words on lined paper (suitable to their year level). Participants in Pre-primary and Year 1 did not write the 20 words as they were still developing an understanding of words. Both the recognition and production samples were taken in one session. The learners were allowed to write in the font used within the classroom. There was no time limit on this assessment.

Measures

The RRR[19] consists of letters and numbers that are presented in mixed orientation in isolation and in combination. The RRR was analysed using the Rasch Measurement Model to create eight highly reliable, linear uni-dimensional scales[22-24]. The final eight scales displayed items that are ordered from easy to hard and the student measures from low to high on the same scale. The scales showed no statistically significant interaction of student measures on item difficulties along the scale, meaning that there was good agreement about the item difficulties along each scale, and each scale was unidimensional. The item-trait chi-squares, fit residual statistics and the targeting was reasonable for all eight scales. Rasch Measurement scales for the RRR can be found elsewhere[19,25]. Learners were asked to indicate the letters and numbers that were presented in the incorrect orrientation if in isolation and the words that contained a letter presented in the incorrect orrientation when letters are presented in context. In addition, learners taking the test were required to print the alphabet from memory, to write the numbers zero through to nine and to write twenty dictated words that collectively included every letter of the alphabet, and the most commonly reversible letters (e.g., b/ d/ p/ & g)[26]. Each letter or number was rated as correct (identified the reversal) or incorrect (did not identify a reversal or identified a non-reversed letter or number as reversed). The words were taken from the 200 most frequently used sight words in the English language[27] and included three, four and five letter words such as bed, boy, nut, lazy, snack, and happy. The written letters are scored as correct if they were produced in the correct orientation and incorrect if they were produced in the reversed orientation.

Data analysis

Data were tabulated using an Excel spread sheet and imported into SPSS19 for analysis. Correlations of letter and number rever-

sal in writing and recognition were analysed using Spearman Rank Order Correlation due to the nonparametric nature of the data. Chi-Squared tests were computed to determine the difference in reversals in written and recognised letters and numbers.

RESULTS

Letters

Disproportionate letter reversal percentages were noted in the letters j (9.5%), and z (11.9%), while the letters b/ c / i / q / t were produced in the reversed orientation by 0.8% of the learners, the letters d / l / p were produced in the incorrect orientation by 1.6% of the learners, and the letter 's' was produced in the incorrect orientation by 2.4% of the learners. Of note is that there was a large percentage (varying between 11% and 20%) of learners who did not attempt to write many of the letters as they were unsure of how they were formed or were unable to form the letters. Fourteen learners (11%) only wrote numbers. In addition, some learners left out the letters g (4.8%), k, o, q, t, u (5.6%), w (6.4%), l (7.2%), x (7.9%) and v (9.5%). This may have influenced the frequency of reversed letters in this sample.

When relating written letters to recognised letters for consistency, a significant difference was found for 'z' in Year 1 (X^2 (1, N=36)=4.69, p=.03) and Year 2 (X^2 (1, N=64) =6.62, p=.01); and for 'j' in Year 3 (X^2 (1, N=60) =6.30, p=.01) meaning that these letters were not equally reversed in both the recognised and written form.

All letters written within a word were found to be significantly negatively correlated to the grade the participants were in. This means that fewer difficulties with letter orientation within words occur as the learners' year level increased. This was not the case for letters written independently in the alphabet, with the letters z / u / t / r / q / n / k / j / g having no correlation to the increased grade level and the letters d / f / h / l / m / p / v / x / y only showing a correlation at the p = .05 level. Eight of the letters: z (r= -.235, p= .008), u / t / q / n/ k/ g (r= -.258, p= .004), and j (r= -.266, p= .003) that do not correspond to the increasing grade also relate to previous research which found these letters to be difficult for learners to write and recognise in the correct orientations. Four letters indicated a poor correlation to learner grade: d (r= -.179, p= .044), f (r= -.224, p= .012), p (r= -222, p= .013) and y (r= -.206, p= .021) also fall into this category.

Correlations were also drawn for letters in context, that is, whether a participant found it as challenging to identify letters with the incorrect orientation in a word, as it was for them to write those letters when writing words. Significant correlations of letters in context occurred in eight letters b (r= .371, p< .000), f (r= .383, p<.000), h (r= .296, p= .001), r (r= .453, p= .453), s (r= .304, p= .001), t (r= .236, p= .008), u (r= .258, p= .001), and w (r= .307, p< .000), while a further two letters n (r= .203, p= .023) and o (r= .179, p= .045) displayed a correlation above the 0.05 level. A significant difference in year levels was found when letters were produced within a word for Year 3 related to 'p' (X^2 (1, N=60) = 7.37, p=.007); 'e' (X^2 (1, N=66) = 6.76, p=.009); 'b' (X^2 (1, N=66) = 8.07, p=.005); 'b' (X^2 (1, N=66) = 6.74, p=.009); and in Year 4 "t" (X^2 (1, N=44) = 8.15, p=.004).

Numbers

The numbers 1 and 8 are not reversible; however eight of the 118 learners were unable to write these numbers. All the other numbers were reversed by at least two learners: with number 6 being the numeral reversed the least often and 7 being the numeral reversed the most. The number orientation difficulty sequence when writing was 6 (1.6%), 4 (3.2%), 2 (4.8%), 5 (5.6%), 3 (7.1%), 9 (8.7%) and 7 (10.3%), which agrees with the number recognition research literature which suggests the most difficult numbers to recognise in increasing order of difficulty when presented are 7 / 9 / 3[6,8,19]. When learners wrote the numbers in the reversed orientation, there was also a greater chance of them failing to recognise a reversed number in a calculation. Chi-Square differences were found for Year 1 learners, these related to the numbers 3 (X^2 (1, N40) = 4.40, p=.036) and for Year 3 learners, Chi-Square difference was found for 4 (X^2 (1, N=44) = 6.74, p=.009). The number 6 displayed a Chi-Square difference for Year 3 learners (X^2 (1, N=63) = 6.76, p= .009); while the number 7 was significantly different for both Year 1 (X^2 (1, N=33) = 8.42, p=.004) and for Year 3 (X^2 (1, N=63) = 6.76, p=.009) and the number 9 was significantly different for Year 3 (X^2 (1, N=63) = 6.74, p=.009).

DISCUSSION

In this study, the eight letters which were found to be difficult to identify or read in the correct orientation (c, s, t, d, q, z, i, j) were also difficult for learners to write in the correct orientation. In addition, five of the letters that learners wrote in the incorrect orientation also correlate with the letters that have been identified in other studies as the most difficult letters to write (q, z, j, t, i)[8,19,21]. Ten letters were found to be difficult to write in the correct orientation when they appeared within a word in this study, (b, f, h, r, s, t, u, w, n, o). Five of these letters, the f / s / t / n / u, were also among the letters identified in earlier research as letters that learners found challenging[8,19,21]. This would imply that the surrounding letters do not assist in identifying the direction of these letters when they appear in the context of a word and may even confuse learners. When the analysis was focussed on the learners recognising and writing letters, the same letters: b, c, d, i, j, l, p, q, s, t and z posed a reading and writing problem. Some learners did not attempt to write several letters. These omissions indicate that certain figures are challenging for primary learners to form, this is not necessarily due to the directional complexity of the letter, for example: o, w, l (except in fonts characterised by a directional curl or tail at the end of the letter), x and v. This indicates that for some learners their reversal difficulties may relate to the action or their limited practice in forming such letters when learning to write.

Of further note is the seeming lack of correlation with increasing age/year level in the number of reversals that occur in written work. Participants tended to reverse the same letters and numbers when writing and recognising with the exception of Year 3 where the learners appeared to have a greater difference between the letters they wrote and the letters where they recognised incorrect orientations. This could suggest that learners who reverse letters when young continue to do so as they become older unless the cycle or habit is broken by relearning. Therefore, there may be some learners who do not "outgrow" the tendency to reverse letters, but may need explicit teaching to recreate the correct formation; however this theory requires further investigation with a larger cohort of older learners. Thus, it may be erroneous to accept reversals in Pre-Primary to Year 2 learners as simply being maturational difficulties, as this research suggests that some older, more mature learners in Years 3 & 4 continue to have difficulties with reversals. Especially as entrenched reversals are difficult for Year 3 and Year 4 learners to correct as their letter/number formation patterns have by this time become entrenched. In addition, the correlation of similar letters reversed in writing and recognition suggests that it may be difficult to use the strengths of the mechanics of writing or the perception of recognition to remediate the incorrect reversal.

One outcome of this research is that it provides an indication of the letters and numbers that teachers need to devote more attention to when their learners are learning how to write, read and spell. For instance, the letters 'j' and 'z' appear to be the most difficult letters for learners to write and recognise in the correct orientation. These letters are also not common in the English language[27] which may be one reason why little emphasis is placed on the teaching of the directionality of these letters. This study similarly suggests that greater emphasis also needs to be placed on teaching the most commonly reversed letters in the English language (b / d / p / q) as they too are easily confused due to their similarity in shape and sound[26]. Additionally, the study provides evidence that letters 't' and 'c' also require more attention. Collectively, the study's findings provide support for the notion that the basic visual perceptual skills that underlie reading and writing (e.g., laterality) are important in the development of the correct

orientation of letters and numbers, and should be considered when instituting corrective reversal teaching methods[3,12].The results suggest that letters 'i' and 'l' also require further attention given that these letters are not generally considered to be letters which learners commonly reverse, however, because certain letter fonts have a 'tail' at the end (*i*,*l*) this can result in these letters being reversed. In cases of remediating tailed cursive 'i' and 'l's teachers may consider allowing learners with reversal issues to revert to manuscript print which alleviates the need for a curl at the end of both letters. This print option may also assist learners with 't' curve reversal problems as letter t, could be produced as a 't' without the curve. However, while this print correctional approach helps with written production it does not remediate the learner's underlying directionality confusion on a two dimensional plane. Hence, reversal remediation should be addressed at a foundational level to avoid the development of functional difficulties[10.26]. For example, in reading a map or confusing letter directionality in reading (e.g. big / dig). Furthermore, some letters (z, u, t, q, n, k, g, j, d, f, p and y) do not improve as the child progresses in grade level[8,19,21] indicating that the letter orientation difficulty is not self-correcting with age either in writing or in reading and, therefore, specific remediation of these difficulties needs to be applied. Importantly, the study's findings also demonstrate a need for greater emphasis to be placed on teaching the written formation and recognition of the orientation of these letters, particularly in the earlier foundation years, as the orientation and formation does not necessarily self-correct with year advancement. Thus, explicit teaching of letter formation and directionality may assist in overcoming orientation difficulties.

Reversing numbers appear to be linked to the starting position and starting direction of the numbers when written[2,8]. Numbers which should start at the top and in which the initial direction of movement in writing the number is to the right (2 / 3 / 7) are the ones which seem to be most problematic. The number 5 depends on the way a child forms the number. It appears from observation that the learners who consistently reverse the number 5 are the ones who start forming it by beginning at the horizontal line at the top, rather than by beginning with the vertical stroke. Finally, it is likely that the reason why numbers 6 and 9 tend to be reversed is that learners often confuse these numbers with the letters b / d and q / p which appear to look the same, and thus cause confusion in letter writing as well[1,2]. Numbers often correlated with other numbers, suggesting that if a child had difficulty with the directionality of one number (e.g., 9), then they are likely to also have the orientation difficulties in writing other numbers (e.g., 5) in addition to orientation difficulties of other numbers that include that number (e.g., 69, 99, 59).

Limitations

The study was limited by the fact that that all the data were collected on one occasion, which could have conceivably resulted in some instances in an individual learner operating at a suboptimal level on the day, and thus, their data not being fully indicative of their skills. However, given the size of the sample it is unlikely that a few individual cases of sub-par performance would skew the results. Another limitation of the study was that it involved a non-random selection of schools and pupils and participation was restricted to one metropolitan school district.

CONCLUSION

This research has shown that many of the letters that learners reverse when writing are the same letters that they reverse when reading. This implies that reversals which occur in reading and writing may be easier to correct if basic perceptual processes that underlie reading and writing such as the learner's sense of laterality is addressed in the remediation process. These basic perceptual remediation processes should initially be considered prior to instituting compensatory methods; however compensatory methods may also be used in conjunction with the remediation process. In addition, it would appear that the font used in writing and reading may impact on the learners' tendency to reverse letters and numbers. Hence, occupational therapists and remedial teachers need to address the basic concepts of bilateral integration, laterality and handwriting font selection prior to attempting to correct the child's writing and reading orientation. Further research into effective methods of remediation involving visual perceptual concepts, verbal prompts in recognition, as well as kinaesthetic prompts involved in writing letters and numbers correctly are warranted.

Explicit teaching of letter and number formation will assist learners with reversal tendencies to correct their reversals as this direct approach will provide them with clearer guidelines and greater sensory input as they learn. As such teachers/therapists may need to develop a repertoire of strategies and rhymes to talk learners through the corrective action; as this will provide learners with the opportunity to talk themselves through the action as well as benefit from the proprioceptive input of carrying out the action. Importantly, this study's finding that the lack of maturational improvement in reversal recognition and production in learners in Years 3 and 4, clearly indicates that learners with reversal issues do not learn to correct their directionality by themselves and, therefore are in need of an external prompt for relearning correct figure directions.

This research adds valuable knowledge for occupational therapists working with school aged learners as it reinforces the need to specifically intervene in the correction of letters and numbers for children with difficulty, rather than assuming that the learner will be able to overcome these difficulties spontaneously. It also draws attention to the specific letters and numbers those learners find challenging, not only related to directionality but also in formation (letters learners did not attempt to write).

Implications

The outcomes of this research indicate that therapists should have a more direct approach to intervention when dealing with learners who are finding letter and number directionality confusing. Consideration of changing font style of writing may also improve outcomes for these learners. For the learner, this research provides guidance in the specific letters and numbers to pay attention to.

Further research now needs to be conducted on the best teaching methods and underlying skills of letter and number recognition in order to develop teaching practices that can eliminate letter and number reversals before they become ingrained habits. Another beneficial avenue for future research is an investigation of the complexities of different font usage as an aid to assisting learners overcome their reading and writing letter and number orientation confusions.

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Developing capacity amongst adolescents attending a leadership camp

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ABSTRACT

There is a need to reduce risk-taking behaviour amongst adolescents and for them to become involved in promoting their own health and wellbeing, as well as that of their communities. One aspect of a promoting health in schools approach is to develop young people's competencies in understanding and influencing, their lifestyles and living conditions. This article focusses on how leadership capacity was developed in a group of learners who attended a leadership camp as part of a health promoting school project in the Western Cape. The aim of the study was to explore a group of learners' experiences of their participation in a leadership camp and how this developed their leadership skills. The study was conducted using an explorative qualitative approach. Two focus groups were conducted with six learners who attended the camp. Four themes emerged from the thematic analysis of the data: (1) Becoming myself; (2) Learning life's lessons; (3) I can take on the world; and (4) Health promoting schools make a difference in my life. The findings of the study indicate that developing leadership capacity is embedded within, and part of, a broader process of empowerment. Occupational therapists' understanding of the link between health and occupation enables them to make a valuable contribution to planning and implementing appropriate leadership camps for adolescents.

Key words: Adolescents; health promotion; leadership camp

INTRODUCTION

Many adolescents in South Africa, and particularly those living in low socio-economic contexts, are faced with a variety of challenges on a daily basis. These contexts often include societal problems associated with poverty such as violence and gangsterism[1] which place adolescents at risk of engaging in behaviours such as substance use. The national Department of Basic Education is concerned about the academic performance and progress of learners from schools in low socio-economic contexts and how their community and economic status impact on their learning and progression in school[2]. According to Broman, Nichols and Kennedy, cited in Kheswa[3], children from low socio-economic backgrounds often have disorganised