Foop is Still Floop: A Six Year Follow-Up of Phonological Dyslexia and Dysgraphia*

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ABSTRACT: A six year follow-up of a previously documented case of developmental phonological dyslexia, is reported. Overall reading and spelling levels have risen significantly, but the qualitative nature of the performance has remained unchanged: impaired non-word reading; morphological and visuo-semantic paralexias; and function word substitutions in text. Rhyming skills also remain impaired. A higher proportion of errors are paralexias and within these a higher proportion are visuo-semantic or morphological. The error pattern of phonological dylexia is thus more pronounced than before. In spelling, only a minority of errors are phonologically plausible. There is no evidence of the mastery of the alphabetic "stage" of reading or the alphabetic "stage" of spelling. It is argued that A.H. is reading orthographically not logographically and that current reading models, which require passage through an alphabetic "stage" before attaining an orthographic stage, do not adequately account for individual variation in the acquisition of literacy skills.

KEYWORDS: Dyslexia, dysgraphia, reading outcome, spelling, neuropsychology, phonological impairment.

Following the papers of Marshall and Newcombe (1966, 1973), psycholinguistic analyses have been used to develop information processing models of reading and reading disorders in neurological patients. A comparable methodology was used in the description of developmental phonological dyslexia (Temple and Marshall 1983). Subsequently, many further studies of developmental phonological dyslexia have been conducted (Temple 1984a, b; Seymour and MacGregor 1984; Campbell and Butterworth 1985; Temple 1985; Snowling, Stackhouse and Rack 1986; Seymour 1986; Temple 1987, 1988a). In this syndrome, there is selective impairment in the development of the phonological reading route which is essential for the accurate pronunciation of unfamiliar words with regular

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spelling patterns. The phonological reading route may also be important in the accurate pronunciation of affixes and short grammatical function words (Patterson 1982).

The accuracy of the phonological reading route is commonly investigated by experimental psychologists, using tasks requiring the pronunciation of letter strings, which conform to the orthographic rules of English but which do not have meaning. The capacity to read these non-words is contrasted with the capacity to read matched words. In phonological dyslexia, the superior reading of words over non-words is accomplished by the use of an apparently normal lexical reading route, in which, following visual analysis, an abstracted representation of a stimulus word triggers an appropriate input logogen (Morton 1969). This in turn accesses a semantic representation which triggers an output logogen to attain pronunciation. This reading route is not sensitive to the spelling-to-sound regularity of a word but is sensitive to imageability and frequency.

The developmental phonological dyslexic A.H., who is the focus of this paper, has previously been documented in detail, in relation to his performance at age ten (Temple 1984b, 1985, 1986). He is of above average intelligence [Verbal I.Q. 123; Performance I.Q. 117] and vocabulary, with normal speech and no abnormality on neurological examination. When tested at age ten, he displayed all the symptoms of developmental phonological dyslexia. He showed a significant lexicality effect, reading words better than matched non-words. He showed no regularity effect, with words with regular and irregular spelling-to-sound patterns being of comparable difficulty. His paralexic reading errors were predominantly visual paralexias [60%] and morphological paralexias [15%].

In the first case description of developmental phonological dyslexia (Temple and Marshall 1983), H.M., displayed a dissociation between the development of phonological skills in reading and spelling. Despite the failure to establish a competent phonological reading route, H.M. had developed a phonological spelling route. She had a spelling disorder but whilst a phonological dyslexic, she was a surface dysgraphic. However, not all phonological dyslexics display dissociations between the pattern of their reading and the pattern of their spelling. Temple (1986) described the spelling pattern of two children of comparable age and overall reading and spelling ability. One child was a surface dyslexic and one was a phonological dyslexic. The developmental phonological dyslexic was A.H. In addition to his impaired phonological route, he also showed impaired development of the phonological spelling route. Fewer than one fifth of A.H.'s spelling errors were phonologically plausible and spelling of regular words was no better than spelling of irregular words. It was suggested that A.H. might have impaired development of the segmentation component of the phonological spelling route and therefore be overreliant on an, albeit imperfect, lexical-semantic spelling route. Spelling age matched controls

differed qualitatively from A.H. indicating that his pattern of reading did not merely represent developmental lag.

One criticism of the previous psycholinguistic analyses of the developmental dyslexias and dysgraphias is that they do not address the dynamics of reading and spelling. Whereas neurological patients may display consistent patterns of reading and spelling, in children the literacy skills are in evolution. Provisos to this contrast are that neurological patients may not show stable performance until sufficient time has elapsed from their brain injury; that patients such as those with dementia or tumours clearly show continuous changes; and that, with the exception of rare reports, (e.g. Barry 1984), consistency studies have not been systematically conducted to verify the stability of reading and spelling patterns in other neurological patients. Traditional developmental descriptions of many cognitive processes, including reading and spelling, in normal children, focus on the sequence of stages in performance which may be observed over time. Following traditional Piagetian notions, these stages are seen as invariant in order with each essential for the development of the subsequent stage.

Frith's (1985) model of reading and spelling development has received wide citation. In this model, there are three stages in reading development: logographic; alphabetic; and orthographic. The phases follow in sequential order with each capitalizing upon the previous stage. In the logographic stage, words are recognised as integrated units. The child has no ability to attempt the pronunciation of any unfamiliar words as she has mastered no phonic rules. As the logographic stage develops errors may be constrained by particular salient letters in the stimulus which are also found in the response. Morton (1989) argues that the mechanisms which are involved in the logographic phase are those which are also involved in picture recognition and the skills do not reflect a linguistically distinct processing module. In the alphabetic phase spelling-to-sound rules are established. Errors are particularly apparent to irregular words where logical rule-governed pronunciations may evoke neologistic responses. By the end of the alphabetic phase the child should be able to pronounce aloud with accuracy unfamiliar regular words. In the orthographic phase, adult reading mechanisms become fully established. Words are systematically analysed into orthographic units (ideally morphemes) without phonological conversion. These units are internally represented as abstract letter-by-letter strings.

Developmental phonological dyslexia is of interest in relation to this reading model as there is failure to establish the alphabetic stage of reading. Frith (personal communication) considers that whereas developmental surface dyslexia can easily be explained as arrestment of development in the alphabetic phase, developmental phonological dyslexia cannot be explained within her reading scheme. Morton (personal communica-

tion) argues that developmental phonological dyslexics are arrested at the logographic reading stage. If this is correct they have succeeded in building up a very large repertoire of words which they recognise but one might anticipate that there would be some upper limit to the ability of these logographic skills to continuously expand. If the developmental phonological dyslexics are reading orthographically rather than logographically, then they have attained this stage without going through an alphabetic stage and the sequence of stages in the Frith model is not necessarily sequential nor is each necessarily essential. Regrettably, because of lack of specification of the precise way in which these stages operate, there appears to be no simple way to test whether reading in developmental phonological dyslexia is logographic or orthographic. However follow-up towards the end of formal schooling will indicate whether there has been a conspicuous limitation on the word recognition skills which have been established. Further, it will indicate whether alphabetic skills are eventually established. If the phonological dyslexic is reading logographically then if alphabetic skills are eventually established the overall pattern of reading should alter to resemble surface dyslexia. If the phonological dyslexic is reading logographically and alphabetic and then orthographic skills are eventually established then reading should become normal. If the phonological dyslexic is reading orthographically and alphabetic skills are eventually established then the stages of Frith are not invariant in sequence. If alphabetic skills fail to become established then the nature of reading performance may not alter qualitatively. In this case, any dynamic progression of reading will reflect quantitative expansion of a specific reading mechanism or stage rather than a developmental progression in the nature of the stage. With such an outcome, reading development need not progress through stages at all. In this case, the snapshot views of developmental dyslexia provided by case analyses at one period in time may be valid predictors of later reading patterns. A comparable range of issues and arguments are relevant in relation to developmental dysgraphia and its development over time, since the Frith (1985) model also describes logographic, alphabetic and orthographic stages in normal spelling development.

The data to be reported below represent the first long term follow-up of a case of developmental phonological dyslexia. It delineates the nature of reading and spelling skills in A.H., six years after his original investigation (Temple 1984b, 1985, 1986). A.H. is now sixteen. In the intervening years A.H. has continued to attend a mainstream school. Some extra-curricular remedial tuition took place at home in the first years after diagnosis. These did not follow any preset pattern. A.H. also learnt to use a computer and practised various reading, spelling and typing skills with it. A.H.'s mother worked with him at home throughout the six years, helping him in his reading wherever she could. Both parents encouraged A.H. to

take an interest in books and to develop independent reading for his own interest.

FOLLOW-UP REPORT

Standardised Reading and Spelling Levels

A summary of the quantitative change in A.H.'s reading and spelling levels is given in Table 1. Reading gains are impressive. On the Schonell single word reading test, the progress in reading age has almost kept pace with the progress in chronological age. Since the scale on the Schonell test ends at age fifteen, it is doubtful whether one would consider the score of 13 years 8 months as continuing to represent an overall deficit in general reading level. On this test, the types of words at the 14—15 year old level are of low frequency e.g. *rescind, judicature, somnambulist,* and *idiosyncrasy.* The gains on the Neale analysis of reading, which is a test of accuracy in text reading, are less extreme, though since the scale for the Neale test ends at age 13, gains of more than 4 years 10 months would not, in any case, have been measurable. The nature of the reading errors in text contrasts with that of single word reading and both are discussed below. Spelling progress is also clear with gains of 4 years 11 months in the intervening six chronological years.

It is also noted that digit span which was previously 5 forward has increased to 7 forward, thus continuing to be at a normal level. Digit span backwards has increased from 3 to 4 and remains somewhat low.

Reading Errors

A.H. was presented with a variety of reading lists to read aloud: the Schonell single word reading test [n = 100]; Marshall's Derivational list [n = 96]; The Coltheart regularity list [n = 78] (Coltheart et al. 1979); Core 80 [n = 80] (Temple 1984c); The Coltheart Lexical Decision List [number of words = 45]; and the Temple word/non-word list [number of

Table 1. Standardised reading and spelling levels

			Increase
Chronological Age	10.2	16.3	6.1
Schonell Reading Age	8.2	13.8	5.6
Neale Reading Age	8.2	11.11	3.9
Schonell Spelling Age	7.8	12.7	4.11

words = 29]. In total, these comprise 428 single words. Of these, 391 (91%) were read correctly. Of the errors, 71% were paralexias and 27% were neologistic responses. The neologistic responses occurred to low frequency words and half arose when reading words interspersed with non-words. There was one refusal. Of the paralexic responses, 27% were visual paralexias, in which stimulus and response shared at least fifty per cent of letters, (e.g. *antique* → "arithmetic"; *sort* → "soft"; *preliminary* → "primarily"), 19% were visuo-semantic paralexias in which stimulus and response shared 50% of letters and a semantic relationship (e.g. *preliminary* → "primarily"; *complaint* → "compliment"; *presupposition* → "presumption"), and 54% were morphological paralexias, in which the base lexical item was read correctly and a morphological ending was added, omitted or substituted (e.g. *furniture* → "furnish"; *sick* → "sickness"; *caution* → "cautious").

These percentages are compared with the error pattern six years previously. At that time, 58% of A.H.'s errors were paralexias and 42% were neologisms. Thus, there is an increase in paralexic responses now. The current proportion of paralexic responses for A.H. is comparable to the level of paralexic responses, of another developmental phonological dyslexic, M.H., who was described previously with A.H. (Temple 1984a). In this previous study, both A.H. and M.H. were ten years old and thus the high proportion of paralexic responses for A.H. now, is not merely a feature of his greater chronological years or higher reading age.

Within the paralexic responses, the percentage of visual paralexias has fallen and the percentages of both visuo-semantic paralexias and morphological paralexias have increased (see Table 2). It should be noted that in the previous report, morphological paralexias are referred to as derivational paralexias. There now seems to be agreement that the term morphological should be preferred as it is linguistically accurate, including both inflectional and derivational errors. For comparative purposes the data for R.B., the surface dyslexic at age 10, are also included. The shift in the error distribution for A.H. takes him even further away from this surface dyslexic pattern.

Table 2. Analysis of paralexic reading errors

ERROR	A.H. (age 16)	A.H. (age 10)	R.B. (age 10)
VISUAL PARALEXIA	27%	60%	74%
VISUO-SEMANTIC PARALEXIA	19%	5%	1%
MORPHOLOGICAL PARALEXIA	54%	15%	3%
PSEUDODERIVATIONAL	0%	5%	0%
VALID PARALEXIA	0%	6%	19%

Ellis and Marshall (1978) have argued that 10% of random pairings of English words have a semantic relationship. Thus, for A.H. at age 10, it could be argued that the appearance of visuo-semantic errors is merely an artifact of the restraints of English. Such an argument does not apply to the current data, as 19% of errors have a semantic component. However, morphological errors are clearly the most dominant error type now. This is comparable to the developmental phonological dyslexic J.E. (Temple 1984a), who was studied at the age of 17, with a reading age of 12 years 4 months, and for whom 55% of overt paralexias were morphological.

In summary, as A.H. has got older there is no suggestion of his error distribution becoming more like that of surface dyslexia. Instead, it resembles the picture of other, previously described phonological dyslexics.

In reading the relatively simple Neale text passages there were 13 errors to 497 words. Of these, 8 (61%) involved functors; being either substitutions (e.g. *for* → "of"; *his* → "this"), omissions or additions. All function word substitutions involved visually similar functors. Omissions and additions were all of definite and indefinite articles. There were two visual paralexias, two morphological paralexias and one other word addition. There were no neologistic responses. Thus, on the analysis of text reading, errors involving grammatical function words are substantially the most dominant error category. The reading of text in general, by either acquired or developmental dyslexics, has been little discussed. However, J.E. (Temple 1984a), the seventeen year old developmental phonological dyslexic was also reported to produce a significant number of function word errors in text, despite the fact that she made no errors when these words were presented in isolation. K.S. (Temple 1988b), whose pattern of developmental dyslexia is the closest reported to that of deep dyslexia, also had function word substitutions as his most dominant error category (69%) when reading text. In his case many more errors were made, since his reading age was only 5 years 2 months.

Reading Dimensions

Lexicality. On Temple's words and non-words, A.H. read 29/29 words and 26/29 non-words correctly performance is near to ceiling and these proportions do not differ significantly. On Coltheart's Lexical Decision list (1979) of short and long words and non-words A.H. read 25/25 short words correctly and 20/25 short non-words. With the long stimuli, A.H. read 9/20 words and 1/20 non-words. In total 63/74 words and 47/74 non-words were read correctly ($\chi^2 = 7.97$, $p < 0.01$, Yate's correction applied). Thus, a significant lexicality effect has persisted. Errors to short non-words included both lexicalisations (e.g. *chold* → "cod"; *toble* → "tomb") and incorrect non-word responses (e.g. *foop* → "floop"; *poad* → "proad"). Despite the persistence of an overall lexicality effect it is clear

that non-word reading abilities have improved. The majority of short non-words are now being read correctly. Whether these skills reflect the partial development of a phonological reading route or the expansion of complex analogy strategies remains open to debate. It was notable that neologistic responses to long low frequency words or non-words on the Coltheart lexical decision list contained substantive word sub-components (e.g. *existentialism* → "extensionalism"; *imparsonious* → "impassionus"; *cirsemicular* → "cirmycircular". This tendency was previously noted in H.M. (Temple and Marshall 1983) and Mr. R. (Temple 1988a).

Regularity. On the Coltheart et al. (1979) regularity list, there were only three errors, with 37/39 irregular words and 38/39 regular words read correctly. Within Core 80 (Temple 1984c) are 20 regular and 20 irregular words (see Temple 1986 for listing), balanced for length in letters, imageability and frequency. There were four errors to these forty words: 2 regular and 2 irregular. On both lists, performance is at ceiling and there is no significant difference between regular and irregular words.

Imageability and Frequency. Core 80 contains 20 words of high frequency and imageability; 20 words of high imageability and low frequency; 20 words of low imageability and high frequency; and 20 words of low frequency and low imageability. There were four errors to Core 80 each of which fell into a separate imageability and frequency group. Performance is at ceiling.

Overall, only lexicality effects remain conspicuously apparent.

Spelling

A.H.'s overall spelling level on standardised testing has increased by 4 years 11 months since the previous report (see Table 1). Although the gain has not kept pace with the increase in chronological age, of 6 years 1 month, it does represent a marked improvement in spelling ability.

Temple (1986) reports an analysis of the spelling errors made by A.H. to a list of 160 words. The schema involved in this error classification was that developed by Hatfield and Patterson (1983). The identical list was redictated to A.H. for written spelling and the errors were subjected to an identical classification. Sixteen errors were made. This represents an improvement from spelling 41% of the list correctly to spelling 90% correctly. The results of the error classification are summarised in Table 3. It is readily apparent that despite the improvement in the quantitative level of spelling performance the qualitative nature of the spelling errors and their relative distribution remains unchanged. In particular, only 12.5% of the errors are phonologically accurate and most errors (81%) are Consonant or Combination errors. The precise errors are listed in Table 4.

Table 3. Analysis of spelling errors

ERROR	PROPORTION A.H. (age 16)	A.H. (age 10)	R.B. (age 10)
PHONOLOGICALLY PLAUSIBLE	12.5%	17%	52%
(+ b-d confusion	—	—	9%)
SUB-TOTAL	12.5%	17%	61%
PHONEME-GRAPHEME ERROR:			
Missing or extra final e	6%	3%	5%
Hard-soft g	—	—	3%
SUB-TOTAL	6%	3%	8%
OTHER:			
Wrong vowel	12.5%	16%	11%
Vowel dropped	—	4%	—
Vowel added	12.5%	—	—
Consonant error or combination	56%	60%	20%
SUB-TOTAL	81%	80%	31%

Table 4. Spelling errors

Phonologically Plausible:	
"whistle" → whisle	"dumb" → dum
Phoneme-grapheme Error:	
"mope" → mop	
Wrong vowel:	
"joyful" → joyfoul	"throat" → throught
Vowel added:	
"mattress" → matteress	"audience" → audiency
Consonant or Combination:	
"secretary" → secerty	"chorus" → chours
"orchestra" → orchester	"adjective" → adchective
"join" → journ	"champion" → champigon
"disgrace" → disc	"cheery" → cherry
"variation" → various	

Amongst the Consonant and Combination errors, the error "champion" → *champigon*, may have been influenced by the French word champignon. The last three errors in the table may be paralexic responses. The error "variation" → *various* is a morphological paralexia.

It could be argued that it is not valid to compare the spelling analysis which was conducted on 94 errors in the previous report, with a spelling

analysis based on only sixteen errors, and that since a single error constituted a variation of 6% of the total, a percentage analysis may be misleading. The comparison is justified by the use of an identical stimulus word list but in addition a further analysis was conducted. The current spelling errors on the 160 word list were combined with the spelling errors made to the Schonell list and the spelling errors made to the dictation of a brief text passage. In total this produced 55 errors, to be subjected to an identical classification. Using this method of analysis, a similar pattern emerges. A minority of errors are phonologically plausible [11/55 20%], the majority of errors being Consonant or Combination errors [41/55 75%].

The Temple list of words and non-words was also dictated for written spelling. These relatively short stimuli were written competently. All of the 29 words and 26 of the non-words were correct. The non-word errors comprised two consonant errors and one vowel error. A phonological spelling system has developed to some degree, but despite this, the incidence of phonologically accurate errors has continued to be low.

Rhyme Fluency. The rhyme fluency task requires the child to generate as many rhymes to a given target as possible, in one minute. There are twelve targets, each of one syllable and each with a different stressed vowel. A.H. is now able to generate 36 rhymes in total, a mean of three rhymes per word. There is some improvement on his score at age 10, but he still does not reach the level attained by the surface dyslexic R.B., with whom A.H. was compared six years previously. At age 10, R.B. could produce 40 rhymes. A.H. and R.B. were also tested on this task at the age of 14 (Temple 1987). The results for all the rhyme tasks are given in Table 5. At

Table 5. Rhyme Fluency

	AGE	READING AGE	RHYME FLUENCY
(Data from Temple 1986)			
A.H.	10	8.2	26
R.B.	10	8.7	40
(Data from Temple 1987)			
A.H.	14	11.8	33*
R.B.	14	10.1	49
Controls	10	10.10	45.6 (SD = 6.8)
A.H.	16.3	13.8	36**
Controls	11.9	11.11	61.25 (SD = 2.8) [Range 47—77]

[*: $p < 0.05$; **: $p < 0.001$]

age 14, R.B. continued to perform much better than A.H. and within the normal control range. A.H. was significantly poorer than controls. The oldest controls who have been tested on this task are nearly 12 (Temple, in press). They are four chronological years younger than A.H. and their average reading age is 22 months below his. Despite this, A.H.'s current performance is significantly poorer than these controls. Indeed his performance is outside their range.

Despite the improvement in overall reading levels, rhyming skills remain significantly poorer than normal children of younger chronological and reading ages. There appears to be no simple relationship between performance on the rhyme fluency task and reading. A.H.'s rhyme skills are as poor as those which R.B. had when her reading age was 8 years 7 months. Yet A.H. has a reading age of 13 years 8 months. Thus, for the surface dyslexic R.B., deficits in sound organisation were clearly not causal in reading difficulty. Further, for A.H. sound organisation skills have not developed as a consequence of improved reading attainment.

CONCLUSIONS

The follow-up of this developmental phonological dyslexic after a six year time period, indicates good improvement of reading and spelling levels. In this case, the poor phonological skills have not been a serious handicap in the long term.

The types of reading errors have remained consistent and the error pattern has only altered, in that, those error types particularly characteristic of phonological dyslexia are shown in increased proportions i.e. morphological and visuo-semantic errors account for a higher percentage of errors. A lexicality effect persists with non-words being more problematic than words. In text, function word substitutions are dominant. A.H. is still unambiguously a phonological dyslexic.

There has been some improvement in non-word reading. Some phonological skills have developed or complex analogy strategy is employed, as suggested by many of the non-word errors. If some phonological skills have developed they have not affected the overall error pattern. There are no regularisation errors. There is no evidence of mastery of the alphabetic "stage" of reading since, despite improvement errors continue, even to some relatively simple non-words.

The pattern of spelling errors is very similar to previously and errors are predominantly non-phonological. Again, there is no clear evidence of mastery of an alphabetic "stage".

Despite the gains in word reading levels, rhyming skills show only slight improvement from before and are still significantly below control levels and also below the level of the surface dyslexic R.B., when her reading age

was 8 years. It was noted that R.B.'s reading problems cannot have been the result of rhyming problems given A.H.'s reading development with comparable current rhyming skills. It was also noted that improved reading has not caused sound organisation skills to develop in A.H.

A large sight vocabulary and near to normal reading level supports the notion that A.H. is reading orthographically not logographically. The high incidence of morphological errors further supports this view, indicating that linguistically appropriate segmentation is taking place to input. This orthographic reading stage has been attained, and indeed had been attained at age 10, without passing through an alphabetic "stage". Therefore stage models of reading development are inappropriate as they do not account for the individual variation in the nature of reading acquisition.

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