Morphological Awareness in Developmental Dyslexia

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This study examines morphological awareness in developmental dyslexia. While the poor phonological awareness of dyslexic children has been related to their difficulty in handling the alphabetical principle, less is known about their morphological awareness, which also plays an important part in reading development. The aim of this study was to analyze in more detail the implications of the phonological impairments of dyslexics in dealing with larger units of language such as morphemes. First, the performance of dyslexic children in a series of morphological tasks was compared with the performance of children matched on reading-level and chronological age. In all the tasks, the dyslexic group performed below the chronological age control group, suggesting that morphological awareness cannot be developed entirely independently of reading experience and/or phonological skills. Comparisons with the reading-age control group indicated that, while the dyslexic children were poorer in the morphemic segmentation tasks,

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they performed normally for their reading level in the sentence completion tasks. Furthermore, they produced more derived words in the production task. This suggests that phonological impairments prevent the explicit segmentation of affixes while allowing the development of productive morphological knowledge. A second study compared dyslexic subgroups defined by their degree of phonological impairment. Our results suggest that dyslexics develop a certain type of morphological knowledge, which they use as a compensatory reading strategy.

INTRODUCTION

The importance of phonemic awareness in the mastery of the alphabetical principle is well established (Goswami & Bryant, 1990; Gough, 1996; Share, 1995). Although it is acknowledged that reading and phonological awareness are reciprocally related, the failure to develop phoneme awareness appears to be a major cause of specific difficulties in learning to read (Goswami & Bryant, 1990; Snowling, 1980). Problems in handling graphemes are directly connected to the difficulty of identifying, isolating, and manipulating phonemes. In addition, inability to complete phonological awareness tasks reflects a general weakness in phonological processing (McBride-Chang, 1996; Olson, 1994; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993).

In alphabetic systems, written units carry morphological as well as phonological information, and there is now growing evidence that not only phonemes but also morphemes are processed in alphabets. Morphology refers to an organizational level of language that deals with the smallest units of meaning: the morphemes. The word "unacceptable" contains three morphemes (un, accept, able), and the meaning of the whole word is roughly the product of the combination of the morphemes. There are different kinds of morphemes: roots, that may or not be words themselves ("accept"); and bound morphemes, that cannot be words, the prefix ("un") and the suffix ("able"). There are also inflections marking gender, number, and tense. Thus, the meaning of an unknown word can be guessed from decomposition into its morphemic constituents, or, conversely, new words may be created by combining morphemes (see Clark & Berman, 1984 for an account of productive morphology in young children). Morphemes carry phonologic, semantic, and syntactical information. Indeed, bound morphemes are meaningful units and suffixes, but not prefixes, and may change the syntactical category of a word ("acceptable" versus "acceptance").

In French, as well as in deep orthographies like English, some transcriptions are best represented at the morpheme level rather than at the phonological level. For example, the French word “femme” (woman), pronounced /fAm/-, is considered irregular from a phonological point of view but as morphologically regular because of the connection with “féminin” (feminine), féminité” (feminity), and so on. There are also many words that end with a consonant which serves as an inflectional marker and sometimes a derivational one as well: in “chat” (cat), the silent “t” is heard in the feminine form “chatte” and in the derived form “chaton” (kitten). The presence of these morphograms indicates that morphological as well as phonological information is encoded in spelling. From an experimental point of view, many studies have indicated that expert readers process morphological information when reading isolated words (Colé, Segui, & Taft, 1997; Feldman, 1995).

According to Schreuder and Baayen (1995), morphological processing may involve three stages. The first stage “concerns the mapping of the speech input onto form-based access representations of full as well as bound forms . . . The second stage, licensing, involves checking whether representations that have become co-active can be integrated on the basis of their subcategorization properties. The third stage, combination, deals with the computation of the lexical representation of the complex word from the lexical (syntactic and semantic) representation of its constituents, given that this integration has been licensed” (Schreuder & Baayen, 1995, p. 133).

Metalinguistic abilities have been recognized as a major determinant of reading acquisition (Gombert, 1992). Morphological awareness, as part of metalinguistics, involves reflection on language and its use and skills of monitoring and planning. According to the framework proposed by Gombert (1992), metalinguistic abilities are based on epilinguistic abilities, which roughly correspond to an implicit knowledge organization. Two points are important for our purpose. First, while epilinguistic skills develop spontaneously, the development of metalinguistic skills is nonobligatory and may depend on external factors such as learning to read (Duncan, Seymour, & Hill, 2000). Second, metalinguistic abilities are characterized by conscious monitoring of the processing performed on language, and are not mastered simultaneously but according to the complexity of the systems, their frequency, and their utility in new tasks.

The assessment of morphological awareness covers a wide range of tasks that test the deliberate manipulation of morphemic units. They may differ in the level of control exerted and along a continuum of more or less analyzed knowledge. As indicated in a previous study (Casalis & Louis-Alexandre, 2000), the various morphological tasks may lead to different levels of performance and do not develop simultaneously, particularly in relation to reading acquisition. In a sense, the domain of morphology is a broader one than that of phonology, and sensitivity to morphemes may be considered as easier to achieve. Indeed, morphemes are meaningful, increasing in their salience, may be produced in isolation, and represent a more "natural" cut on the language (Fowler & Liberman, 1995).

THE DEVELOPMENT OF MORPHOLOGICAL AWARENESS

Following Berko (1958), Carlisle (1988) developed the sentence completion task and administered it to first to sixth graders. The effect of the phonological change of the base in the derived form (*four/fourth* versus *five/fifth*) was investigated and the phonological-change condition was found to be harder than the no-change condition (Carlisle, 1988; Fowler & Liberman, 1995). In other tasks, third and sixth grade children were asked to distinguish derivationally-related word pairs (*natural-nature*) from foil pairs that were related in spelling but not in morphology (*ear-earth)* (Mahony, Singson, & Mann, 2000). Further tasks directly requested the subject to isolate morphemes such as the word counting task (Elbro, 1989) or the word segmentation task (Casalis & Louis-Alexandre, 2000). In the latter task, children were given a morphologically complex word, which they had to segment into two morphemes (base and affix). Several studies have indicated that scores on morphological tasks are strongly correlated with reading achievement (Mahony, 1994). Furthermore, the contribution of morphology score to reading achievement increased progressively (Grades 4 to 6), supporting the view that morphological awareness plays a role in later reading development (Mahony, 1994). However, effects are also observed early in development (Grades 1 and 2), indicating that morphological awareness could be important as soon as children start learning to read (Casalis & Louis-Alexandre, 2000).

PHONOLOGICAL AND MORPHOLOGICAL AWARENESS

Mann (2000) emphasized that morphological awareness presupposes an awareness of phoneme and syllable-sized units. Developmental studies indicate that morphological awareness is strongly correlated with phonological awareness. Given the importance of the latter in learning to read, it seems necessary to determine the specific role of morphological awareness in reading acquisition.

Two sets of results illustrate a close or even dependent relationship between morphological and phonological awareness. In the sentence completion task described above, the base could be phonologically changed or not in the derived form. Since the phonological change condition was found to be more difficult, this indicates a strong dependency on phonological abilities in the morphological process (Carlisle, 1988; Casalis, 2001; Fowler & Liberman, 1995; Shankweiler et al., 1995). Additional evidence is provided by segmentation tasks. For example, Casalis (2001) found that suffix deletion in a derived word was easier when the suffix corresponded to the whole of the last syllable—as in *noir/noirceur* (black/blackness)—compared with the case when removing the suffix necessitates "breaking up" the last syllable as in *rouge/rougeur* (red/redness). Such a result clearly indicates that morphological segmentation is dependent on phonological segmentation, at least in languages such as French, in which the syllable is a salient unit (Segui, Dupoux, & Mehler, 1990).

In all these studies, phonological and morphological tasks were highly intercorrelated. This strong association suggests convergence on a common ability. However, there is some evidence that morphological awareness is not just secondary to phonological awareness. Regression analyses indicate that morphological scores make a small but significant contribution to the reading variance, over and above the contribution of phonological abilities (see Carlisle & Nomanbhoy, 1993; Casalis & Louis-Alexandre, 2000, for studies with first and second graders; Singson, Mahony, & Mann, 2000, for a study with third to sixth graders). Thus, there are empirical arguments in favor of an independent, although small, role of morphological awareness in learning to read.

MORPHOLOGICAL AWARENESS AND DEVELOPMENTAL DYSLEXIA

The question of the relationship between phonological and morphological awareness is central to the consideration of morphological awareness in developmental dyslexia. Dyslexia is traditionally defined as a reading (word recognition) disability, which may occur in spite of normal intelligence, good social and educational opportunities, in the absence of emotional disturbance, neurological disease or sensory deficit (Olson, 1994); usually without any semantic deficit (Vellutino, Scanlon, & Spearing, 1995), but is strongly associated with poor phonological abilities

(Stanovich, 1988, 1996). Two different points of view may be distinguished concerning the development of morphological awareness in developmental dyslexia: the phonological deficiencies of most dyslexic children may prevent them from developing normal morphological abilities, or morphological awareness could develop independently in the context of learning to read and the semantic units conveyed in oral language.

Relatively few studies have investigated morphological awareness in dyslexia. Compared with chronological age controls, dyslexics have been found to be poorer in the production of a derived form in a sentence completion task, especially when there is a phonological change in the derived form (Fowler & Liberman, 1995; Shankweiler et al., 1995). However, the comparison with reading-level matched children is more puzzling. No difference was found between dyslexic and younger normal readers in tasks such as word derivation in a sentence context (Fowler & Liberman, 1995), production of derived, inflected and compound forms of pseudowords (Elbro, 1989), and synthesis of morphemic element (Elbro, 1989). Thus, the picture that emerges is that dyslexic children may have poor morphological abilities, but largely as a consequence of their poor phonological abilities and lack of reading skill. However, dyslexics were found to be poorer than younger children in reversing elements of compound words (*mailbox* to *boxmail*) and counting the number of words in sentences read aloud to them (Elbro, 1989). In addition, in a derivation task with written sentences involving phonological and orthographic changes, Leong (1989) found that the different subgroups of poor readers were differentially affected by the kind of modification occurring between base and derived forms, suggesting that some categories of poor readers could be particularly affected by phonological or orthographic changes.

In all, the results differ according to the control group with which the dyslexics were compared, and the tasks used in the morphological awareness assessment. An important point concerns control group design. As Joanisse, Manis, Keating, and Seidenberg (2000) pointed out, reading level group was crucial to their design because various cognitive and language skills are related to reading achievement. Taking the reading-level group into account can counterbalance any effect reading achievement might have had on the various language skills being measured.

GOALS OF THE STUDY

Important questions remain about the nature of morphological processing in dyslexia. It is necessary to specify in more detail how dyslexics perform in oral morphological tasks and in which ways they differ from normal readers. Of central concern is the relationship between morphology and phonology. Given their poor phonological abilities, it is expected that the tasks that involve segmentation will be less well performed by dyslexics than tasks that focus more on meaning.

The level of performance of the dyslexic group might be analyzed in two ways. First, the well-known phonological impairments could impede the development of morphological awareness. Second, poor readers' poor reading experience might prevent them from benefiting from orthographic information in order to extract morphemes (Carlisle, 1988). The first issue was examined in manipulating the phonological information in the morphological tasks (phonological change of the base in the derived forms, syllable status of the suffix to be removed) in Study 1, and was directly tested in Study 2 by comparing dyslexic subgroups differing in phonological abilities. The second issue was addressed in Study 1 within a design involving two groups of normal readers: the first was matched on chronological age, while the second was matched on reading level in order to equate reading experience.

STUDY 1

Comparison of dyslexic and control groups in various morphological tasks

The main objective of the present research was to determine how dyslexic individuals perform on morphological awareness tasks. From a metalinguistic framework (Bialystok & Ryan, 1985), a first distinction may be proposed between tasks that involve morphological derivation in sentence completion and tasks that place a heavier load on explicit segmentation. Where sentence completion is required, production of the derived form may be driven by various aspects of the linguistic context such as syntactical properties. In our study, two different sentence completion tasks were used. In the first one, the base (or derived) form was pronounced in isolation by the experimenter followed by the sentence to be completed (as in the classical Berko's task). The second task was like a definition task. The derived form had to be produced from a morphologically related word or pseudoword inserted in the sentence corresponding to a definition (examples: "The man who robs is a robber"/"celui qui vole est un voleur;" "The man who lies is a liar"/"celui qui ment est un menteur"). Since attention was directly focused on the meaning conveyed by suffixes, the difficulty might be more important for young children than for dyslexics who might rely more on meaning. The use of pseudowords in addition to real words allowed us to assess suffixation without support of lexical knowledge. The other tasks tested more explicit manipulation, involving the segmentation or assembly of the base and affix. In segmentation it was expected, following Schreuder and Baayen (1995), that phonological constraints might play a role. Segmentation was expected to be more difficult than blending, particularly for dyslexic children, given that segmentation results in the production of two strings that do not necessarily correspond to words, while blending results in the pronunciation of a word. The former situation also involves the segmentation of the phonological string. That is the reason why the segmentation process, in a base identification situation, was further studied in relation to syllable segmentation. Indeed, syllables are salient units in the processing of the French words. Thus, the question of whether the syllable status of the bound morpheme may affect the base-suffix segmentation was examined. Finally, a production task was included in order to examine morphological fluency or the ability to use morphological knowledge to produce complex words.

METHOD

PARTICIPANTS

A dyslexic group and two control groups of readers (chronological-age control and reading-age control) participated in this study. There were 33 dyslexic children (22 boys and 11 girls) aged between 8 years 3 months and 12 years 8 months (mean age 10 years 1 month). Dyslexic children (DYS) were recruited through speech therapist offices. They were all enrolled in long-term reading remediation and were recognized as dyslexic since their reading impairment was not due to a lack of stimulation that could be readily remediated (Vellutino et al., 1995). To ensure that they met the dyslexia criteria, they were submitted to a general intelligence test (*Coloured Progressive Matrices*) (Raven, 1976). Children whose performance fell below the 25th percentile were eliminated from the study. The children were also given the Alouette text reading test (Lefavrais, 1967), which assesses accuracy and speed in reading aloud. The score gained indicated a reading-age level. To be considered dyslexic, the criterion was a reading delay of 18 months for children under 9 years and of 24 months for children over 9 years old. None of the children suffered from language impairment, hearing problems, neurological disorders or emotional disturbance, and none came from very low income families. Finally, they all had French as their first language.

The reading age mean (as measured by the Alouette test) in the dyslexic group was 7 years 3 months. The reading-age control group (RAC) was constituted on the basis of the Alouette scores so that the reading-ages of the two groups were equated. The RAC group consisted of 20 first graders (11 girls and 9 boys) and 13 second graders (7 girls and 6 boys). This gave a control group of 33 subjects matched for reading-age, whose mean chronological age was 7 years 5 months and mean reading age 7 years 5 months. The chronological-age control group (CAC) consisted of 33 children with a mean chronological age of 10 years 2 months and a mean reading age of 10 years 9 months. Chronological-age control children were matched to dyslexic children with a close one-by-one matching procedure. Consequently, a large span of ages was also observed in chronological age (ranging from 100 to 158 months).

MATERIALS

Various kinds of tests were administered: a comprehension task, reading tasks, and phonological and morphological awareness tasks.

Syntactical Comprehension Task. Comprehension was assessed by the syntactical semantic comprehension test *L'ECOSSE* (Lecocq, 1996). The first part of the test consisted of a vocabulary test, which served to verify that no vocabulary problems could impede sentence comprehension. The results showed that all the children knew the tested words, and there was no difference between groups. The second part of the test was a French adaptation of the test for receptive grammar, or TROG, by Bishop (1989), in which individual children heard or read a sentence. Once the sentence was heard or read, the children were shown four pictures and they had to choose the one corresponding to the sentence. As distractors, there were syntactical pitfalls and lexical changes. Reading comprehension and listening comprehension were scored as measured by the number of errors in the choice of pictures. There were 46 sentences for each modality. Pictures and written sentences were presented in a booklet and responses were manually recorded.

Reading Task (Casalis, 1995). The children were presented with a list of 40 regular words, 20 irregular words (according to grapheme-phoneme correspondence rules), and separately, 20 pseudowords. The items were presented individually on cards.

First Phoneme Suppression Task. As a phonological awareness task, the children had to pronounce what remained once the first phoneme of short or long pseudowords had been removed (e.g., *dri-ri; groupal-roupal*). There were 20 items in this task.

Derivational morphology tasks included the following.

Morphological Analysis. This task contains two parts. In the blending section, the children had to pronounce a morphologically complex word given the base and the affix (e.g., *nettoie* and *age* give *nettoyage*). In the segmentation section, the children had to pronounce the two parts (base and affix) of a morphologically complex word (e.g., *gagnant* gives *gagne* and *ant*). The experimenters pronounced the affixes and bases in the blending part and the complex words in the segmentation part. There were 20 items in all, 10 items for each part. Half of the complex words were prefixed and half were suffixed.

Suffix Deletion. The children had to say the base of a suffixed word pronounced by the experimenter. In half of the cases, morphemic segmentation necessitated the suppression of a final syllable (e.g., *journée/jour*); in the other half, morphemic segmentation involved an intrasyllabic segmentation at the end of the word (e.g. *sagesse/sage*). For each situation, namely "preserved syllable" and "broken syllable," there were 10 items. In contrast to some earlier tasks, the children had to pronounce the base only, and base forms, as different from affixes, often correspond to real words. This procedure was chosen in order to focus on the syllable constraint in the base identification.

Both the morphological analysis and the suffix deletion tasks assessed morphemic manipulation in the absence of contextual cues that may facilitate lexical retrieval.

Derivation in Sentence Completion. The children had to complete a sentence with either a derived word (in half the cases) given the base, or a base word (in the other half) given the derived word. In half of the items, the base did not undergo a phonological change in the derived form (as in *poli/politesse, polite/politeness*). In the other half, the base did undergo a phonological change in the derived form (as in *vieux/vieillesse, old/oldness*). The context of the sentence was neutral from a semantic point of view, as for example *politeness/this boy is. . . .* There were 10 items in each condition.

Production after Definition. The children had to complete a sentence with a derived form. The sentence had the form of a definition and the context drew attention to the meaning of the derived form. In half of the cases the items were words (e.g., *celui qui dessine est un . . . dessinateur*). In the other half, the items were pseudowords (e.g., *celui qui plude est un . . . pludeur*). There were 10 items for words and ten items for pseudowords.

Morphological Fluency. The children were asked to produce as many words as possible belonging to the "same family" of a given word. They were instructed to produce words that contained the "same little piece of the word" but that did not have exactly the same meaning. There were five target words.

PROCEDURE

The children were tested individually: the dyslexic children in the speech therapist's office, and the control children in a quiet room in their schools. Three sessions of 40 minutes each were necessary to collect the data. Each subtest was preceded by two examples and two training items. There were no data for the CAC group syntactical comprehension and morphological fluency.

RESULTS

Since the dyslexic group may be seen as an inconsistent group (Rack, Snowling, & Olson, 1992), we will present the reading characteristics of our sample first. Table I summarizes results for the syntactical comprehension, reading, and phonological tasks, and reviews scores obtained in the morphological tasks.

In the syntactical comprehension test, the data were analyzed with a 2 (group) x 2 (modality) ANOVA design (there being no data for the CAC group). The RAC group outperformed the DYS group (F [1, 64] = 9.277, $p < .001$). There were more errors in reading than in listening (F [1, 64] = 59.87, $p < .001$), particularly for the DYS group (F [1, 64] = 32.113, $p < .001$, for the interaction). Further analyses indicated that while there was no difference between groups in listening comprehension (F [1, 64], $p > 1$), the dyslexic children made more errors in reading comprehension (F [1, 64] = 20.94, $p < .001$).

A 3 (item) x 3 (group) MANOVA was conducted on the results of the reading task. The groups differed (F [2, 96] = 38.9, $p < .001$), and there was an effect of item category (F [2, 192] = 42.9, $p < .001$) and an interaction between the factors (F [4, 192] = 19.96, $p < .001$). Further analyses (post hoc Newman-Keuls) indicated that while the DYS group was outperformed by the CAC group for all categories of items ($p < .001$), there was no difference between DYS and RAC in regular and irregular words, but RAC outperformed DYS in pseudoword reading

TABLE I. Number of errors in the syntactical comprehension and percentage of accuracy (standard deviation in parentheses) in phonological awareness, reading, and morphological awareness.

		Dyslexic group	Chronological age control	Reading age control
Syntactical comprehension	Listening	5.45 (2.54)	_	5.03 (2.64)
	Reading	9.18 (3.49)	_	5.61 (2.82)
First phoneme suppression		56.63 (30.32)	96.36 (6.52)	88.94 (10.29)
Word reading	Regular	82.12 (15.66)	91.28 (6.58)	80.68 (11.10)
	Irregular	58.79 (23.15)	84.39 (13.85)	63.03 (14.84)
	Pseudowords	50.76 (22.74)	91.52 (11.0)	80 (11.52)
Morphological analysis	Blending	78.64 (12.83)	94.29 (7.87)	84.44 (26.84)
	Segmentation	49.09 (11.09)	92.86 (11.13)	63.33 (21.14)
Suffix deletion	Preserved syllable	92.73 (8.76)	99.09 (2.92)	91.52 (14.39)
	Broken syllable	82.12 (19.0)	96.97 (6.37)	89.70 (10.15)
Derivation in sentence completion	No phonol change	77.27 (18.07)	93.03 (10.75)	75.76 (14.37)
	Phonol change	52.12 (21.47)	79.09 (15.88)	49.39 (17.49)
Production after definition	Words	70.91 (18.60)	86.36 (9.62)	66.97 (19.76)
	Pseudo words	40.30 (19.28)	90.61 (11.97)	54.55 (20.93)

($p < .001$). Individually, 22 dyslexics scored 2 SD below the RAC mean in pseudoword reading, six of these dyslexics scored between –2 and –0.5 SD, and five scored above –0.5.

In the first phoneme suppression task, there were large differences between groups (F [2, 96] = 48.326, $p < .0001$). Post-hoc comparisons indicated that while the difference between CAC and CAL failed to reach significance ($p = .11$), both the CAC group and the RAC group outperformed the DYS group ($p < .05$). Thus, our sample of dyslexic children was characterized by poor phonological skills, as indicated by impaired phonological awareness and poor pseudoword reading. However, the dyslexics did not differ from the RAC children in the word reading tasks. Finally, our target group was matched with the reading age control group on listening comprehension. We now turn to the morphological awareness assessment.

MORPHOLOGICAL AWARENESS TASKS

In order to test our hypotheses, the data were analyzed in two steps. First, a MANOVA aimed to compare general performance of the groups in all the morphological tasks (except the production task). Second, specific effects manipulated in each morphological task were examined in separate ANOVAs. In the 3 (group) x 4 (task) MANOVA, there was a large effect for groups (F [2, 96] = 77.94, $p < .0001$). Pairwise comparisons indicated that the CAC outperformed both the RAC and the DYS groups ($p < .01$) while the RAC group outperformed the DYS group ($p < .05$). There was also a task effect (F [3, 288] = 83.1, $p < .0001$). Newman-Keuls post hoc comparisons indicated that scores of all the groups decreased significantly from the identification of the base, then analysis, and then both sentence completion tasks. The difference between derivation in context and production after definition was only marginally significant. However, there was also an interaction between tasks and groups (F [6, 288] = 8.46, $p < .001$), suggesting that the difference between groups varied across tasks. Inspection of the results indicates that the analysis task induced the largest variation between groups while the identification of the base induced the smallest variation. Specific comparisons were carried out in further separate ANOVAs.

Morphological Analysis Task. The data were submitted to a 2 (segmentation versus blending) x 3 (group) ANOVA. There was a main effect for groups (F [2, 44] = 11.228, $p < .001$). The DYS group performed globally worse than the RAC group (F [1, 42] = 4.60, $p < .05$). Blending was easier than segmentation (F [1, 44] = 29.559, $p < .001$), and this effect was different across groups (F [2, 44] = 5.618, $p < .01$) Further comparisons indicated that while there was no difference between groups in the blending task (F [2, 44] = 1.843, ns), the segmentation task induced more variation of performance (F [2, 44] = 20.787, $p < .001$). Pairwise comparisons established that the RAC group outperformed the DYS group ($p < .01$) but did worse than the CAC group ($p < .01$).

In the suffix deletion task, the data were analyzed in a 3 (group) x 2 (syllable status) ANOVA design. There was a main effect for group (F [2, 96] = 12.783, $p < .0001$). Pairwise comparisons indicated that the CAC group outperformed other groups

(p <.01) and the RAC group outperformed the DYS group. In addition, a syllable effect in the morphemic segmentation suggests that removing a suffix when it coincided with the last syllable was easier than when it corresponded with a smaller part (F [1, 96] = 10.329, p < .01). There was an interaction between group and syllable status (F [2, 96] = 3.645, p < .05). Only the DYS group displayed a significant effect of syllable status (F [1, 32] = 9.146, p < .01). Pairwise comparisons indicated that all groups differed in the "broken" condition while there was no difference between RAC and DYS in the "preserved" condition.

In the derivation in sentence context task, the data were analyzed in a 3 (group) x 2 (phonological change versus no change) ANOVA design. There was a group effect (F [2, 96] = 25.286, p < .001). Pairwise comparisons indicated that the CAC group performed higher than the RAC and DYS groups, which did not differ from each other (F [1, 64] < 1). The no-change condition was easier than the phonological-change condition (F [1, 96] = 204.016, p < .0001), but this effect varied across groups (F [2, 96] = 6.703, p < .05). Although the regularity effect was statistically significant in all the groups, inspection of the data suggests that the effect was smaller in the CAC group. Pairwise comparisons indicated that there was no difference between the RAC and DYS groups in all the conditions.

In the production after definition task, the data were analyzed in a 3 (group) x 2 (word versus pseudoword) ANOVA design. There were main effects for groups (F [2, 96] = 39.123, p < .01) and lexicality (F (1, 96) = 64.583 p < .0001) and an interaction (F [2, 96] = 39.123, p < .001). Post-hoc Newman-Keuls tests indicated that in the word condition, the CAC outperformed the RAC and the DYS groups (p < .01), while these latter two groups showed no difference. In the pseudoword condition, the CAC group outperformed the RAC group, who outperformed the DYS group (p < .01). There was a lexicality effect in all three groups, although it was only marginally significant in the CAC group.

In the morphological fluency task, the DYS group produced more words than the RAC (F [1, 42] = 15.82 < .001, DYS mean: 8.82, RAC mean: 6.18). In order to analyze the dyslexic responses, four categories of responses were considered:

Category 1: morphologically related words, which were included in the dictionary;
Category 2: responses that were acceptable, given the generative nature of morphology (for example "redéplier is not registered in the dictionary but is acceptable);

Category 3: morphologically unrelated words (generally semantically or phonologically related); and
Category 4: pseudowords (most often sharing the base).

Among the responses given by the children of the DYS and RAC groups, 60% for the DYS and 50% for the RAC were morphologically related words that appear in the dictionary (Category 1), 78% for the DYS and 65% for the RAC were recognized as derived words (Category 2, which included Category 1), 8% for the DYS and 16% for the RAC were unrelated words (Category 3), and 14% for the DYS and 19% for the RAC were pseudowords (Category 4). The proportion of categories of responses differed with the groups ($\chi^2 = 15.02$, $p < .05$). Examination of the relative contributions indicated that the effect occurred because the RAC group produced more words that were not morphologically related (most often semantically related), while the DYS group produced fewer unrelated words. Thus, it appeared that the dyslexics produced not only more responses in these production tasks, but overall, they produced the highest proportion of morphologically related words. This suggests that both components of morphological production rules (semantic process and word formation rules) were not underdeveloped in dyslexic children.

DISCUSSION

Our first study aimed at examining various aspects of morphological awareness in dyslexic children. An important point is that the dyslexic French readers have poor phonological abilities as attested to by their poor pseudoword reading and a low level of phonological awareness. Thus, although the DYS and RAC groups were matched for the word reading level, they were not matched in terms of phonological processing. In comparison with the CAC group, the dyslexic children performed systematically below the normal readers on morphological tasks. This indicates that morphological skills may not develop normally in developmental dyslexia. However, to the extent that they differ from their CAC peers in both reading experience and phonological abilities, it is difficult to draw conclusions.

The development of morphological awareness in dyslexics may be best examined in comparison with reading level matched children. This comparison clearly distinguishes the DYS profile from the RAC profile. Tasks were first distinguished according to whether they tapped productive knowledge of derivation or a more explicit morphemic segmentation process. In general, derivation in context tasks (sentence completion and production after definition) were found to be more difficult than formal analyses (analysis and base identification). This result was not predicted and may suggest that the production of a word or a pseudoword when focusing on the semantic and syntactical properties of the suffix may not be so easy. It should be emphasized that these tasks did not differentiate the DYS and RAC groups except when a pseudoword had to be produced. Conversely, in the formal tasks, the DYS group was outperformed by the RAC group (except on the "syllable preserved" condition of the suffix deletion).

At least two aspects may explain the RAC-DYS difference here. First, these tasks tap the first stage of morphological processing, relying on phonological segmentation. Second, responses may not correspond to words (suffixes have to be pronounced separately in the analysis task). Finally, fluency is greater in the DYS group and, moreover, analyses of responses indicated that the DYS group provided the largest proportion of morphologically related words. This suggests a developmental dissociation in the morphological skills of dyslexic children. Tasks that focus on formal analysis are poorly performed. Those requiring productive knowledge are performed at the level expected according to reading age. The superiority of the fluency score suggests that dyslexics may benefit from oral as well as written language input in order to develop morphological skills. In all, one might hypothesize that morphological knowledge develops differently in dyslexic children than in normal readers.

The poor performance of the DYS group is associated with phonological processing. This may affect the results in the pseudoword sentence completion task, given the well-known difficulties of dyslexic children in pseudoword repetition (Rapala & Brady, 1991). The pseudoword condition includes at least two steps: repetition of a pseudoword and production of an appropriate derived form. In our task, both steps are confounded. Receptive tasks, using pseudowords, are probably necessary to disentangle both steps. Aside from the case of pseudoword derivation, the performance of dyslexic children was impoverished in tasks such as morphological analysis where contextual cues were absent. Here, the subject's attention is directly oriented to the morphological process and he or she must manipulate phonemes as well as morphemes. Removing or adding a suffix implies an analysis of phonological structure in relation to morphological structure. If a child has difficulty in manipulating phonemes, therefore, it could be harder to remove or blend a morpheme, which is not only a meaning unit but also a phonological unit. As we have already seen (Carlisle, 1995, 2000; Casalis & Louis-Alexandre, 2000), morphological tasks may tap phonological abilities but also depend on a morphological level of processing. To what extent is poor phonological awareness directly responsible for poor morphemic segmentation? Fowler and Liberman (1995) and Shankweiler et al. (1995) have pointed out that the interaction between groups of readers and phonological change is a good indication of phonological impediments, but in our study as in previous ones, there was no difference between the RAC and DYS groups in the phonological change effect. These results seem, therefore, to contradict the idea that phonological deficit is the direct cause of poor morphological abilities.

We may obtain some evidence if we manipulate the phonological awareness level of the children. More precisely, while a phonological deficit is the hallmark of dyslexia (Olson, 1994; Stanovich, 1988), it has also been suggested that there are variations among dyslexic children in phonological impairments, and several subgroups may be distinguished according to this view. Thus, if the development of morphological awareness is hampered by poor phonological skills, it would be relevant to compare dyslexic groups who differ in their phonological abilities.

STUDY 2

Morphological process in dyslexic groups who differ in phonological awareness abilities

This second study aims at comparing some aspects of morphological awareness in dyslexic groups who differ in their phonological deficits. In line with Joanisse et al. (2000), we focused here on two categories of dyslexic children: phonological dyslexics characterized by phonological deficits, and delayed dyslexics who exhibit almost normal reading-level matched patterns. Surface dyslexia—as a specific impairment of orthographic representation—is not considered here. Our hypothesis was that a phonological deficit could impoverish morphological awareness if tasks necessitate a particular attention to phonological units. Dyslexics who are particularly impaired in phonological processing are expected to manipulate morphemes more easily than phonemes, except when phonological aspects prevent accuracy in segmentation. Thus, an interaction between subtypes of dyslexia and materials is anticipated. Phonological dyslexics are expected to be specifically impaired in morphological awareness tasks when the morphemic segmentation may be impeded by some phonological characteristic (that is, a phonological change of the base in pseudoword construction or syllable breaking). The comparison between the two categories of dyslexic children may help us to grasp the role of poor phonological skills in morphological knowledge. The comparison of phonological dyslexics with delayed dyslexics is appropriate since they also have poor word recognition skills. Reading experience and chronological age in building morphological knowledge may be equated.

METHOD

PARTICIPANTS

Dyslexics were selected in order to constitute groups, which were contrasted in phonological skills. None of them had participated in the first study. Phonological dyslexics were selected on the basis of poor scores on both pseudoword decoding (Casalis, 1995) and phonological awareness tasks. A criterion of at least two standard deviations below the level expected for reading age was applied. Delayed dyslexics were chosen on the basis of normal scores on both pseudoword decoding and phonological awareness tasks (less than 0.5 standard deviation below the expected level, given their reading age). This resulted in a subgroup of 11 phonological dyslexic (PD) children and another subgroup of 14 delayed dyslexic (DD) children. The groups did not differ in chronological age (F [1, 23], $p < 1$). Similarly, no difference was found in their reading level (F [1, 23] = 3.32, ns). The groups did not differ in irregular words reading (F [1, 23], $p < 1$) with 50% correct (s.d. 22.8) for DP and 56.78% correct (s.d. 18.7) for DD. Thus, the difference between the subgroups lay mainly in their phonological abilities.

MATERIALS

To test phonological awareness, the first phoneme suppression task was administered to the children. To test morphological awareness, three tasks were administered that focused on various phonological effects. First, the suffix deletion task was chosen to examine the effect of the syllable status in suffix deletion. Second, the sentence completion task was chosen in order to examine the effect of phonological change. Finally, the production after definition task was used in order to investigate the lexicality effect in producing a derived form.

RESULTS

Table II shows the percentage accuracy data for the phonological and morphological awareness tasks.

For the first phoneme suppression task, the DD children outperformed the PD children on this phonological awareness task (F [1, 23] = 36.157, $p < .001$). For the morphological suffix deletion task, the DD group outperformed the PD group (F [1, 23] = 6.56, $p < .05$). There was a syllable effect (F [1, 23] = 12.776, $p < .01$), which interacted with group (F [1, 23] = 5.763, $p < .05$). The phonological group was more sensitive to the syllable status than the delayed group (F [1, 21] = 3, 8, $p < .05$). Further analyses indicated that there was no difference between groups when syllables coincided with suffixes (F ([1, 23], $p < 1$), while phonological dyslexics were poorer in removing a suffix that was not as large as a syllable (F [1, 23] = 7.007, $p < .05$).

For the derivation in sentence completion task, there was no difference between groups (F [1, 23], $p < 1$). As before, there was an effect of the phonological condition, since the no-change items were easier to process than the phonological change items (F [1, 23] = 6.68, $p < .05$), but there was no interaction between groups and phonological condition (F [1, 21], $p < .1$). For the production after definition task, there was no group difference (F [1, 23] = 2.87, ns). There was a large effect of lexicality (F [1, 23] = 54.982, $p < .0001$), sentences being easier to complete with derived words than with derived pseudowords. Finally, there was an interaction between group and lexicality. The difference

TABLE II. Percentage of accuracy in phonological and morphological awareness (standard deviation in parentheses).

		Phonological dyslexic		Delayed subgroup	
First phoneme suppression		26.97	(27.1)	78.21	(18.4)
Suffix deletion	Preserved syllable	66.36	(5.1)	67.86	(4.26)
	Broken syllable	51.82	(17.22)	65	(6.5)
Production after definition	Words	79.09	(8.31)	75.71	(13.99)
	Pseudowords	26.36	(26.56)	50.71	(26.45)
Derivation in sentence	No phonol change	67.5	(14.88)	70	(16.33)
	Phonol change	57.50	(12.54)	55.71	(20.70)

between pseudowords and words was larger for the phonological dyslexics than for the delayed dyslexics (F [1, 23] = 6.997, $p < .05$). Further analyses indicated that the groups did not differ in the word condition (F [1, 23], $p < 1$), but did in the pseudoword condition (F [1, 23] = 5.2, $p < .05$).

DISCUSSION

The aim of the second study was to test the importance of phonological impairment in morphological awareness. The hypothesis was that a phonological impairment could prevent the development of morphological knowledge. Our results only partly support this hypothesis. Phonological dyslexics appeared to be impaired in morphemic segmentation, but only when there was heightened demand on phonological segmentation (when the suffix to be removed did not coincide with the last syllable). In the sentence completion tasks, there was no difference between the groups and phonological change had equivalent effects. In fact, the only difference occurred in the pseudoword condition where the phonological dyslexics found it more difficult to pronounce a derived pseudoword. This well-known difficulty in pseudoword repetition may reflect impairments in sublexical segmentation and processing pseudowords, rather than morphological impairments.

Finally, the pattern of results was similar to that of Study 1. Such a result, when compared with normal longitudinal studies, which evidence high correlations between phonological and morphological skills, could indicate that the development of morphological awareness differs between populations and is not so dependent on phonological skills in the dyslexic population. If morphological awareness performance is dependent on phonological abilities only, phonological dyslexics should have been poorer than delayed dyslexics. We have some evidence that this population was indeed particularly sensitive to phonological factors (the syllable effect in morphemic segmentation and poor pseudoword derivational abilities). On the other hand, phonological dyslexics performed as well as delayed dyslexics in the sentence completion tasks as long as real words were involved. This suggests that the development of morphological knowledge does not rely entirely on phonological processing. The fact that delayed dyslexics did not perform better on morphological word tasks may indicate that morphological knowledge depends on both age and reading experience independent of phonological abilities. One cannot exclude the possibility that the delayed children were impaired in linguistic processes such as morphology. But while this has still to be evidenced, there was no such indication in our data.

GENERAL DISCUSSION

The aim of the study was to examine morphological awareness in developmental dyslexia, as assessed by various kinds of tasks, in order to analyze more deeply the role of phonological impairments in processing larger units of language such as morphemes. Overall, the dyslexic children were poorer than their chronological-age control peers. While this may indicate poor morphological abilities, it could more simply be seen as the influence of reading experience on the development of metalinguistic abilities. A contrasting view emerged when analyzing morphological awareness as compared with reading level matched children. In tasks that directly demand the isolation or the blending of morphemes (without the contextual cues), the dyslexics were impaired relative to younger normal readers. This was also the case in the phonological awareness task. Since dyslexics are impaired in both morphemic and phonological segmentation, this could be seen as an argument in favor of a dependency between morphemic and phonological segmentation skills. The ability to segment the phonological string into either phonological or morphological units is particularly impaired in dyslexic children. However, the productive knowledge of derived words, as assessed by the sentence completion tasks, did not appear to be specifically impaired relative to reading level matched normal readers. This supports the view that productive knowledge may be associated with reading level but does not directly depend on phonological segmentation skills. Such a result could mean that children develop productive knowledge of derivation in parallel with learning to read, whatever their phonological skills may be. So one cannot argue that morphological abilities strictly depend on phonological abilities. The differences between the groups in the segmentation tasks suggest, at the same time, that the processes involved in the production of derived words probably differ between normal and dyslexic populations. Given their phonological impairment, dyslexic children may rely more on semantic information and less on phonological information.

This claim is supported by the comparisons between delayed and phonological dyslexics (Study 2). Phonological dyslexics are impaired in phonological awareness and pseudoword reading, while delayed dyslexics have phonological awareness and pseudoword reading scores corresponding to their reading levels. Compared with delayed dyslexics, phonological dyslexics were impaired in the suffix deletion task but not in derivation in a sentence context. For the sentence completion task involving the phonological change effect, the data indicate that there was an interaction between groups (dyslexic versus normal readers) and phonological change in the base form with dyslexics being more affected by phonological changes. This interaction disappeared when dyslexic children were compared with reading level matched children. This suggests that mechanisms used by dyslexics to learn derived words are probably different. They may develop knowledge about derived words more slowly, and perhaps independently of morphemic segmentation skills. They may, rather, rely more on semantic information and less on phonological information since their global level corresponds to their reading level.

In summary, dyslexic children display a particular profile in their oral morphological abilities. Their developmental course is not just delayed and similar to that of younger children. They may have difficulty in morphological segmentation, probably due to their poor phonological skills. But their knowledge about the relationship between base and derived forms in meaningful contexts corresponds to their reading level. This means that their morphological skills develop, at least in part, independently of their phonological skills. Consequently, they may have built compensatory strategies to bypass the impediments caused by their poor phonological skills. This point of view is supported by the results of Elbro and Arnbak (1996) in training disabled readers in morphological analysis. They found that the slight benefits from morphological training were gained independently of phonological abilities. This suggests that morphology develops in dyslexic children and may even constitute a compensatory strategy. It could be particularly relevant to examine more deeply how dyslexics process morphology during reading. Laxon, Rickard, and Coltheart (1992) compared the reading of affixed words and pseudowords in good and poor readers. Their results indicated that both groups read affixed words better than pseudo-affixed words, suggesting a morphological decomposition at the lexical level in both groups. This indicates that morphological processing is not absent in poor readers. However, the nature of this morphological processing still has to be determined. In all, various aspects in morphological awareness should be considered in the field of reading acquisition, especially when considering the possibility of building compensatory strategies for disabled readers.

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References

Berko, J. (1958). The child's learning of English morphology. *Word, 14*, 150–177.

Bialystok, E., & Ryan, E. (1985). A metacognitive framework for the development of first and second language skills. In D. Forrest-Pressley, G. E. MacKinnon, & T. G. Waller (Eds.), *Metacognition and human performance* (vol. 1) (pp. 207–252). New York: Academic Press.

Bishop, D. V. M. (1989). *Test for reception of grammar* (2nd ed.). Manchester: University of Manchester Age and Cognitive Performance Centre: Author.

Carlisle, J. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics, 9*, 247–266.

Carlisle, J. F. (1995). Morphological awareness and early reading achievement. In L. Feldman (Ed.), *Morphological aspects of language processing* (pp. 189–209). Hillsdale, NJ: Lawrence Erlbaum Associates.

Carlisle, J. F. (2000). Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing: An Interdisciplinary Journal, 12*, 169–190.

Carlisle, J., & Nomanbhoy, D. M. (1993). Phonological and morphological awareness in first graders. *Applied Psycholinguistics, 14*, 177–195.

Casalis, S. (1995). *Apprentissage de la lecture et dyslexies de l'enfant [Learning to read and dyslexia in children].* Lille: Presses Universitaires du Septentrion.

Casalis, S. (2001). Morphological awareness and phonological awareness in the onset of literacy. In B. MacWhinney (Ed.), *Research on child language acquisition* (pp. 209–223). Somerville, MA: Cascadilla Press.

Casalis, S., & Louis-Alexandre, M. F. (2000). Morphological analysis, phonological analysis and learning to read French: A longitudinal study. *Reading and Writing: An Interdisciplinary Journal, 12*, 303–335.

Clark, E. V., & Berman, R. A. (1984). Language structure and language use in the acquisition of word-formation. *Language, 6*, 542–590.

Colé, P., Segui, J., & Taft, M. (1997). Words and morphemes as units for lexical access. *Journal of Memory and Language, 37*, 312–330.

Duncan, L., Seymour, P., & Hill, S. (2000). A small-to-large unit progression in metaphonological awareness and reading? *The Quarterly Journal of Experimental Psychology, 53A*(4), 1081–1104.

Elbro, C. (1989). Morphological awareness in dyslexia. In C. Von Euler, I. Lundberg, & G. Lennerstrand (Eds.), *Brain and reading: Structural and functional anomalies in developmental dyslexia with special reference to interactions, memory functions, linguistic processes and visual analysis in reading* (pp. 189–209). London: MacMillan.

Elbro, C., & Arnbak, E. (1996). The role of morpheme recognition and morphological awareness in dyslexia. *Annals of Dyslexia, 46*, 209–240.

Feldman, L. B. (Ed.). (1995). *Morphological aspects of language processing.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Fowler, A., & Liberman, I. (1995). The role of phonology and morphology in morphological awareness. In L. Feldman (Ed.), *Morphological aspects of language processing* (pp. 157–188). Hillsdale, NJ: Lawrence Erlbaum Associates.

Gombert, J.-E. (1992). *Metalinguistic development.* Chicago: University of Chicago Press.

Goswami, U., & Bryant, P. (1990). *Phonological skills and learning to read.* London: Lawrence Erlbaum Associates.

Gough, P.B. (1996). How children learn to read and why they fail. *Annals of Dyslexia, 46*, 3–20.

Joanisse, M., Manis, F., Keating, P., & Seidenberg, M. (2000). Language deficits in dyslexic children: Speech perception, phonology, and morphology. *Journal of Experimental Child Psychology, 77*, 30–60.

Laxon, V., Rickard, M., & Coltheart, V. (1992). Children read affixed words and nonwords. *British Journal of Psychology, 83*, 407–423.

Lecocq, P. (1996). *L'ECOSSE: une épreuve de compréhension syntaxico-sémantique* [The Ecosse: A syntactical semantic test]. Lille: Presses Universitaires du Septentrion.

Lefavrais, P. (1967). *Test de l'Alouette* [Lark test]. Paris: Editions du Centre de Psychologie Appliquée.

Leong, C. K. (1989). Productive knowledge of derivational rules in poor readers. *Annals of Dyslexia, 39*, 94–115.

Mahony, D. (1994). Using sensitivity to word structure to explain variance in high school and college level reading ability. *Reading and Writing: An Interdisciplinary Journal, 6*, 19–44.

Mahony, D., Singson, M., & Mann, V. (2000). Reading ability and sensitivity to morphological relations. *Reading and Writing: An Interdisciplinary Journal, 12*, 191–218.

Mann, V. (2000). Introduction to special issue on morphology and the acquisition of alphabetic writing systems. *Reading and Writing: An Interdisciplinary Journal, 12*, 143–147.

McBride-Chang, C. (1996). Models of speech perception and phonological processing in reading. *Child Development, 67*, 1836–1856.

Olson, R. K. (1994). Language deficits in "specific" reading disability. In M. A. Gernsbacher (Ed.), *Handbook of psycholinguistics* (pp. 895–916). New York: Academic Press.

Rack, J. P., Snowling, M. J., & Olson, R. K. (1992). The nonword reading deficit in developmental dyslexia: A review. *Reading Research Quarterly, 27*, 29–53.

Rapala, M., & Brady, S. (1991). Reading ability and short term memory: The role of phonological processing. *Reading and Writing: An Interdisciplinary Journal, 2*, 1–25.

Raven, J. C. (1976). *Coloured Progressives Matrices*. Oxford: Oxford Psychologists Press.

Schreuder, R., & Baayen, H. (1995). Modeling morphological processing. In L. Feldman (Ed.), *Morphological aspects of language processing* (pp. 131–154). Hillsdale, NJ: Lawrence Erlbaum Associates.

Segui, J., Dupoux, E., & Mehler, J. (1990). The syllable: Its role in speech segmentation and lexical access. In G. Altman (Ed.), *Cognitive models of speech processing: Psycholinguistic and computational perspectives* (pp. 263–280). Cambridge, MA: The MIT Press.

Shankweiler, D., Crain, S., Katz, L., Fowler, C., Liberman, A., Brady, S., Thornton, R., Lundquist, E., Dreyer, L., Fletcher, J. M., Stuebing, K., Shaywitz, S., & Shaywitz B. (1995). Cognitive profiles of reading-disabled children: Comparisons of language skills in phonology, morphology, and syntax. *Psychological Science, 6*, 149–159.

Share, D. (1995). Phonological recoding and self teaching: Sine qua non for reading acquisition. *Cognition, 55*, 151–218.

Singson, M., Mahony, D., & Mann, V. (2000). The relation between reading ability and morphological skills: Evidence from derivational suffixes. *Reading and Writing: An Interdisciplinary Journal, 12*, 219–252.

Snowling, M. (1980). The development of grapheme-phoneme correspondence in normal and dyslexic readers. *Journal of Experimental Child Psychology, 29*, 294–305.

Stanovich, K. E. (1988). Explaining the differences between the dyslexic and the garden-variety poor reader: The phonological-core variable difference model. *Journal of Learning Disabilities, 22*, 590–612.

Stanovich, K. E. (1996). Toward a more inclusive definition of dyslexia. *Dyslexia, 2*, 154–166.

Vellutino, F., Scanlon, D., & Spearing, D. (1995). Semantic and phonological coding in poor and normal readers. *Journal of Experimental Child Psychology, 59*, 76–123.

Wagner, R., Torgesen, J., Laughon, P., Simmons, K., & Rashotte, C. A. (1993). Development of young readers' phonological processing abilities. *Journal of Educational Psychology, 85*, 83–103.

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